Annual Progress Report for the Period 9/15/1999 – 9/14/2000

Environmental Management Science Program

Project ID: 60163

Project Title: Investigation of techniques to improve continuous air monitors under conditions of high dust loading in environmental setting

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Number of Graduate Students: 1

Specific DOE Problems That Are Being Addressed by Your Project, and Potential Practical Relevance to Improved Knowledge, Techniques, Processes, or Technology:

There is a need for improving the sensitivity of detecting airborne plutonium with continuous air monitors (CAMs) to maintain the highest level of safety and regulatory compliance at plant and waste storage operations handling plutonium.

Research Objective:

Improvement in understanding the deposition of ambient dust particles on environmental continuous air monitor (ECAM) filters, reduction of the alpha-particle interference of radon progeny and other radioactive aerosols in different particle size ranges on filters, and development of ECAMs with increased sensitivity under dusty outdoor conditions.

Research Progress and Implications:

As of March 1, 2000 we have tested additional types of dust and membrane filters, and various sizes of radioactive aerosols deposited as a thin layer on an underlying non-radioactive dust layer. These studies simulate detection of the sudden release of radioactive aerosol. The results show that the full width half maximum (FWHM) of the 7.68 MeV alpha particle peak of ^{214}Po varies with filter type and the size of radioactive aerosol particle. The resolution is fairly insensitive to the loading of nonradioactive dust within the range of 0.01 to 10 mg cm^{-2}. Large radioactive aerosols have lower energy resolution compared with small sized ones. Of the filters studied so far, a fluoropore filter

with a 3-ìm diameter pore size provided the best combination of energy resolution and low air resistance. We also studied the deposition of a thick layer of radioactive particles to simulate chronic release where radioactive aerosol particles are buried simultaneously with dust. Degradation of alpha spectrum is evident for this case. Our results suggest that when used only as an early warning detection device under high dust loading conditions, it may not be necessary to change the filters of ECAMs as much as previously thought.

To better interpret the physical processes affecting the energy resolution of our alpha spectra, we developed a numerical model simulating self absorption in radioactive aerosol particles deposited on filters. For example, we studied the resolution for our experiments with glass beads possessing a surface radioactivity of radon decay products. These results show that the resolution of the alpha spectrum is worst with diameter in the size range 0.5–4 ìm. While the FWHM of the main peak appears to be unchanged, the spectra of larger particles show a noticeably elevated background level in the low energy tail and a reduced intensity for the main peak. These results will help predict conditions under which degradation of resolution may become important.

To study how the depositional pattern of aerosol particles on a filter influences resolution of alpha spectra, we developed a new technique that records simultaneously alpha-particle spectra and microscopic video pictures of particles deposited on CAM filters. These results show that particles deposited on a filter have a multilayer structure. The FWHM increases with mass on the filter, as well as percent coverage of the filter. Grouping by impaction is clearly seen in the video pictures. A model is under development to simulate the particle deposition pattern.

To obtain aerosol size information for realistic field conditions, a measurement of the aerosol size distribution at the Waste Isolation Pilot Plan (WIPP) site in Carlsbad, NM was conducted with the collaboration of the Los Alamos National Laboratory and the New Mexico State University Carlsbad Environmental Monitoring and Research Center. The results show that the size distribution of the dust we generate in the laboratory generally resembles aerosol at WIPP, although the latter is slightly smaller than former.

Planned Activities:

We plan to concentrate on analyzing existing data, refining our models, and then preparing suitable papers and reports. Raul Alcantara, the graduate student working on this project, is scheduled to complete his M. S. work this year. If time allows, we will enhance our technique of generating convenient, safe, short-lived radioactive aerosol particles by testing the technique with decay products from a thoron source. This technique (see the submitted paper below) is a serendipitous discovery that may be of significant benefit to a range of operations having to generate and use artificial radioactive aerosol particles.

Information Access:

We have submitted the following manuscript for publication: *Micrometer-sized short-lived radioactive aerosol particles for air monitoring applications* by S. D. Schery, R. E. Alcantara,, S. Huang, and N. V. Dale. A preprint of this manuscript is available from our laboratory. We presented an abstract and poster entitled "*The effect of dust loading on the detection of radioactive aerosol particles with continuous air monitors: Initial results*" at the American Geophysical Union 1999 Fall Meeting in San Francisco.