Mr. Nawab Ali
(Ph.D. Scholar, DPAM, PIEAS)

Topic: Study of Aerosols Deposition Rates using 210 Pb inventories in Soil, Air and Water

Abstract

Atmospherically-derived natural (7Be, 210Pb) and anthropogenic (137Cs) radioactive isotopes in air, rain water and soil have been used to explore and understand the transport processes of aerosols in the atmosphere and their subsequent removal from the atmosphere through wet deposition to
natural surfaces on the earth.

A systematic set of experiments were performed for the measurement of 210Pb and 7Be concentrations in the surface level air samples. The samples were collected on glass fiber filters by using a portable air sampler at the Department of Physics, COMSATS, Islamabad over an 18 months period (July 16, 2007 to January 15, 2009) and measured by employing the non-destructive technique of γ-ray spectroscopy through N-type HPGe spectrometer. The annual average surface air concentrations of 210Pb and 7Be isotopes were determined as 0.284±0.15 and 3.171±1.14 mBq m-3, respectively. The largest and smallest concentrations of 210Pb were observed in air masses approaching to the sampling point from the low lands with no forests and forested high lands, respectively, showing its source region and interception of aerosols by foliar surfaces.
Concentrations of 7Be were found higher during spring season, consistent with its stratospheric source region. Lower concentrations of both radionuclides were observed during periods of high rainfalls, indicating that rain is a dominant removal agent of aerosols from the atmosphere.

The activity and deposition rates of 210Pb and 7Be isotopes were determined in the open rain water and through fall samples, collected from Murree, using γ-ray spectroscopy on HPGe detector. Mean values of concentrations (annual deposition fluxes) of 210Pb and 7Be-bearing aerosols, respectively, in open rain and through fall samples were found as: 210Pb: 29.75±11.02 mBq l-1 (21.06 Bq m-2), 7Be: 572.89±201.36 mBq l-1 (415.60 Bq m-2) and 210Pb: 16.75±6.26 mBq l-1 (9.78 Bq m-2), Be: 441.74±321.04 mBq l-1 (294.56 Bq m-2). Concentrations and deposition fluxes for both isotopes in open rain samples were found comparatively higher than that of through fall samples. Reduction of these quantities in throughfall samples is the manifestation of the fact that rough surfaces of plantation leaves are effectively intercepting radionuclides-bearing aerosols from the atmosphere. Seasonal trend in the concentrations of both radionuclides, similar to air measurements, was observed with the lowest concentration of 210Pb in summer season (consistent with soil as its origin and effectively washed out with rain during the period in South Asia) and the highest concentration of 7Be in spring season (consistent with

stratospheric origin). A positive correlation between 210Pb and 7Be deposition was seen, indicating that these two isotopes can not be used as independent atmospheric tracers.

Activity concentrations and inventories of atmospherically deposited 210Pb and 137Cs radionuclides in undisturbed woodland and adjacent open grassland soils were determined in Islamabad and Murree regions. Based on our results, these values for the 210Pb isotope were found comparatively higher in samples collected under woodland soils than the soil samples of open land, while, that of 137Cs are higher in almost all samples collected from open land soils compared to those samples collected under woodland soils. The depth profile of 210Pb is showing a decreasing trend in its activity along the depth in soils, with the maximum value at the top (0-5 cm) layer of the soil, while 137Cs activity in most samples was found maximum in the 2nd (5-10 cm) and some times in 3rd (10-15 cm) layers, indicating that 137Cs radionuclides have been leached out to the deeper layers of soil with the passage of time.

Radon concentrations in drinking water, indoor air and soil gas samples collected from Islamabad and Murree areas were measured by the active technique, using RAD-7 detector. Higher radon
concentrations were found in the water, indoor air and soil gas samples collected from Islamabad region as compared to that from Murree region. Higher values of radon concentration in water of Islamabad region were found consistent with the origin of radon source (bore hole/well water) and the lower values in the samples of Murree region were indicating the surface source of drinking water and the frequent flow of air at high altitude sites. The contribution of mean annual effective doses from radon contained in the samples of Islamabad and Murree regions were deduced and found lower than the recommended values of UNSCEAR, ICRP and US EPA, thus posing no threat to the health of the local people.

Finally, the latent damage trails of fission fragments in CR-39 plastic detectors (exposed to 252Cf source) were revealed through etching process, using various amounts of Na2CO3-mixed 6M NaOH solutions as etchants. Track etching parameters such as sensitivity, efficiency, etch induction time, track and bulk etch velocities and track activation energies in the detector, were determined. The results were compared with other similar studies and found with nice agreement. The reduced etch induction times and activation energies in CR-39 detectors were observed when etched them at 4% Na2CO3-mixed NaOH solution. Efforts were also made for the fabrication of micro/nano filters in CR-39 detectors, to fractionate the size distribution of aerosols.