Charging of Radioactive aerosols near the Containment wall of Pressurized Water Reactor

Aerosols containing radionuclide are called radioactive aerosols and they are different from other aerosols in that they charge themselves by the emission of charged particles during radioactive decay process. High energy decay products produce bipolar ions in the surrounding gas medium. Radioactive aerosols are charged by the attachment of these ions in addition to their self-charging process. Using a numerical model, charging of monodipersed beta active aerosols is studied in presence of diffusion and drift combined with bipolar and radioactive charging in the vicinity of absorbing wall of a nuclear reactor. Presence of electric field near the wall affects the charging rate of the aerosols. Charging of aerosols is studied for positive, negative and zero electric field

For low electric field (+2 Vcm^{-1}), the mean charge carried by the aerosol particle varies from ~ +2 to -30 units for 0.1 μm radius particle and ~ +2 to -12 units for 0.3 μm radius particle. Charge reversal occurs near the bulk concentration for 0.1 μm particle as compared to near the wall for 0.3 μm particle. For high electric field (+5 Vcm^{-1}), the mean charge varies from ~ -13 to +7 units with charge reversal occurring near the wall. For negative electric field (-2 Vcm^{-1}), the mean charge as high as ~ +50 units are observed. Aerosol particle mean charge is found to increase with the increased ionization rate and decreases as the particle number concentration is increased. The hypothesis proposed by Clement and Harrison (2000) for the generation of self induced electric field has been confirmed quantitatively in the present study. Lower mean charges on the particles are observed due to increased mixing of the ions by turbulence.

Effect of aerosol charging on particle deposition rate is also considered and it is found that for the calculated charges on particles (radius<0.3 μm), deposition can be enhanced by up to 1000 % as compared to neutral particles. Therefore, charging of particles has to be taken into account while calculating the transport of particles from reactor containment to the atmosphere.