**Title: Estimation of mean charge on sodium metal aerosol in the bipolarly ionized argon and nitrogen gas**

**Reviewer query and reply**

Very deep analysis of a phenomenon occurring on Na aerosols in cover gas.

**Reply:** Thank you for carefully reading and appreciation.

**Q.** Abstract: define "bipolar ionic atmosphere"

**Reply:** A mol­e­cule of gas with a free elec­tron attached to it is called a neg­a­tive ion, while a mol­e­cule lack­ing an elec­tron is called a pos­i­tive ion. The space/field where both ions are present is known as the bipolar ionic environment. The explanation was added in the revised article.

**Q.** Section 1 Introduction (Sentence: "However little investigation has been conducted..."): why to address nitrogen, because nitrogen is not used as a cover gas over Na in SFRs? - please define: "bi-polar ions"

**Reply:** We agree with the reviewer’s comment, that nitrogen gas is not used as primary cover gas however, it has been used as inert gas for liquid sodium in various applications/ places. [In SFRs it is used in the space between the main vessel and safety vessel and in some applications like coaxial pipes of primary sodium circuit, cooling gas for winding of annular linear induction pump, and cooling gas for absorber bed for cover gas purification circuit, etc.] The characteristics of aerosol in nitrogen gas play a crucial role in deposition pattern and qualification of sensitivity of Sodium Aerosol Detector (SAD) for leak detection in many sensitive areas of SFRs. Here, the objective of selecting nitrogen gas is to compare the aerosol properties under argon gas (because it has a different asymmetry ratio of mobility of ions) as a part of academic interest.

**Q.** Section 2-2: Equation 3 mobility of positive and negative ions; problems on the characters + -

**Reply:** The correction has been included in the revised article.

**Q.** In section 4 Conclusions: maybe the consequences should be analyzed with regards consequences i.e., deposits in narrow gaps, settling in Na bulk, Cs trapping in Na aerosols....

**Reply:** Thank you for your comments and guidance on improving research publication applicability.

The preliminary calculation has been performed to estimate the magnitude of electric charge on sodium aerosol in inert gases. We assume here that; the concentrations of the positive and negative ions are equal. The magnitude of the charge on aerosol is estimated based on the asymmetry of ion mobilities. Few other processes can modify the level of mean charge, like charging induced by photon interaction with sodium aerosol, diffusion of ions to the walls surface of cover gas space, and if aerosol particle and inert gas (in case of argon) itself radioactive.

Considering the above factor, the consequence of the aerosol characteristics in cover gas space under ionizing radiation on the deposition of aerosol in the annular/ narrow gaps, sodium pool surface, and Cs trapping/ attachment to the aerosol is discussed here.

The deposition of aerosol to the cooler part of the rooftop and the annular gap of the top shield will be enhanced under the ionic field because charged aerosol deposits faster rate on conducting surfaces based on the electrostatic deposition.

Under the ionic environment, the size distribution of aerosol becomes wider, and mean aerosol size is shifted to a larger size range compared to size distribution under a non-ionic environment. Hence, the aerosol deposition to the sodium pool will be enhanced.

In the case of Cs trapping to the sodium aerosol, the aerosols are found to be neutral aerosols species, positive or negatively charged aerosols (based on modified Boltzmann distribution), and radioactive species. When the radioactive Cs are suspended in that medium, the Cs get themselves attached with charged sodium aerosols due to coulomb or image forces and get attached with neutral aerosols. It is inferred that there will be additional trapping due to charged sodium aerosols when compared to uncharged aerosols. The consequence radiation of aerosol properties inside the cover gas region has been included in the revised manuscript.

**Q.** Acknowledgments: IGCAR and not IGACR

**Reply:** Yes, the correction has been appended in the revised article.

**Q.** The paper is a very thoughtful scientific paper. It could benefit from some minor technical editing. It is clearly written and is novel. I would recommend that the paper be scanned again for grammar and minor edits. For example – on page 2 – change “two orders high compared to” to “two orders higher compared to” In addition, on page 5 – “the higher is sodium pool temperature, the more evaporation of sodium and higher” to “the higher sodium pool temperature, the more evaporation of sodium and the higher”. There are a few things like that that just need to get cleaned up to improve the readability of the paper. Please address these comments and upload a revised paper.

**Reply:** Thank you for carefully reading and appreciating the work’s novelty. As per your suggestion, the paper has been checked for readability, and improvements were made. May revised paper will meet the expectation of the audience.