**Title: Spatio-temporal evolution of sodium combustion aerosol and temperature distribution during sodium pool fire in a confined environment**

**Reviewer query and reply**

Dear authors, please see below the comments from the peer review:

Reviewer-1

Q. This article deals with sodium fire. It studies the temperature and particles behavior during a pool sodium fire. It is well written; minor corrections are suggested.

**Reply:** Thank you for your appreciation.

Q. The abstract gives too many details about the experiments. Be more concise by presenting what you study and the main achievements.

**Reply:** The abstract has been revised as per the reviewer suggestions.

Q. §2.5. For K type thermocouples, the accuracy is +/-1°C. You specify +/-0.75%. I guess, it is +/-0.75°C and not a percentage. If not, can you justify and gives the error in °C.

**Reply:** The accuracy of K- type thermocouples is +/- 0.75% of the measured value. The error has been calculated and reported in the revised paper.

Q. A scheme of the location of the thermocouples would be helpful to understand the measurement system.

**Reply:** In the revised article, a schematic diagram of thermocouples locations has been included.

Q. Typos: p2 “Section 3 gives a brief description results…”->” Section 3 gives a brief description of the results…”

**Reply:** Yes, the correction incorporated in the revised article.

Q. P6 “The temperature gradient near the chamber wall was measured using five number thermocouples…”-> “The temperature gradient near the chamber wall was measured using five thermocouples.”

**Reply:** The text has been corrected in the revised article.

Q. P10 “convention velocity…“->“convection velocity…“ ; “The convention is significantly…”->” The convection is significantly…“

**Reply:** Yes, the corrections are appended in the revised article.

Reviewer 2:

Q. The paper discusses the effect of uniform spatial-temporal distribution assumption in aerosol after sodium pool fire experiment. The experimental set up and results are well described. The discussion on code validation is compact but sufficient. No comments on improvements.

**Reply:** Thank you for your review and appreciation.

Reviewer 3:

Q. Interesting paper, some points need to be clarified. The English is sometimes not correct, too long sentences do not help the understanding. Measurement uncertainties are required.

**Reply:** Thank you for your observation. The paper has been checked for readability and reviewed for English grammar and long sentence were rewritten for better readability.

The uncertainty calculations have been performed for most of the parameters and included in the revised article.

ABSTRACT:  
Q. Too long, focus on the main points: source term evaluation, pressure and temperature increase within the room.

**Reply:** The abstract has been revised as suggested.

Q. INTRODUCTION :  
• During a sodium fire, several compounds are generated according to the following reactions:  
• 2Na(g) + ½ O2 (g) ◊ Na2O (s)  
• 2Na(l) + O2 (g) ◊ Na2O2(s)  
But also:  
• Na2O2(s) + H2O (g) ◊ 2NaOH (s) + ½ O2(g)  
• Na2O(s)+H2O(g) ◊2 NaOH (s)  
• Na(l) + H2O(g) ◊ NaOH (s or l) + ½ H2(g)  
The compounds generated at solid and liquid state are included into the aerosol cloud. In your paper, you speak of sodium aerosols, do you only consider, as nucleation sites, pure liquid sodium particles?

**Reply:** The liquid sodium as soon as exposed to the atmospheric air, reacts with O2 and form oxides. The sodium oxide formation is only constrained near pool surface region (combustion zone). The oxides aerosol reacts with moisture and converted to the hydroxide. The oxide to hydroxide reaction is very fast (~ millisecond). Further, the hydroxide will convert to sodium carbonate upon reaction with CO2 then it further converts to bicarbonate. The reaction rate of sodium carbonate and bicarbonate is relatively slow than hydroxide and depend on many parameters like, moisture level, aerosol concentration and CO2 concentration. Here, we assume that aerosol is in the form of hydroxide and then it became carbonate, and bicarbonate. However, for theoretical simulation we have considered aerosol are in the form of NaOH and the density is taken as 2.13 g/cc. The sentences were rewritten in the revised article.

Q. When you mention the different computer codes, you explain that they « assume and simulate homogeneous aerosol distributions in the containment volume ». What do you mean by « homogeneous distribution »? What kind of distribution do you speak about: size? species? velocity?

**Reply:** Homogeneous distribution means, the aerosol characteristics (concentration, size, chemical species, and deposition velocity) are uniform throughout the simulation domain. The aerosol distribution we talk about in the article are concentration and size distribution.

Q. You say, « In the first part, strong experimental data remain necessary… ». What do you mean? Is there a second part?

**Reply:** The second part is 3D modelling based on CFD. For validation of theoretical models, a realistic observations data required. Towards that, an experimental and theoretical work has been started at IGCAR.

MATERIAL AND METHODS  
2.1 Experimental facility  
Q. Is thermal imaging system an infra-red system?

**Reply:** No, Imaging system are optical based used in the present experiment.

2.2 Sodium aerosol generation  
Q. You say, « The sodium supply tank … maintained at a pressure of 0.05 bar (g) ». Do you speak of an overpressure (same question for all the pressures given in this paragraph)? What does « (g) » mean?

**Reply:** Yes, pressure mentioned in the manuscript is gauge pressure, i.e., above atmosphere.

Q. 2.3 Sampling layout inside the experimental hall  
You do not discuss the intrusivity of your sampling equipment. How does it disturb the aerosol cloud? Is there any condensation on these devices?

**Reply:** The aerosol samples were drawn through sampling lines (12 mm OD tubes) and aerosol equipment’s were connected to the sampling line outside of the chamber. Hence, the disturbance to the aerosol cloud is localised and minimum. There was aerosol deposition in the outer surface of the sampling line, which was not quantified in the present experiment. The deposition inside of the sampling tube was quantified and found to be 35.49 µg/m\*min.

RESULTS AND DISCUSSION  
3.2 Temperature distribution inside the experimental hall  
Q. I do not understand the legend of the curves presented in Fig.6: according to the facility description and TABLE 1, there are 4 locations at each elevation. This is not the case in Fig 6.a, Fig. 6.b, and Fig. 6c.

**Reply:** Table 1 is for sampling locations for aerosol characteristics. The temperature was monitored in 9 locations of top and middle elevations, however, for the bottom elevation it is monitored in 7 locations. A schematic diagram of the temperature sensor locations is drawn and included in the revised manuscript.

Q. 3.3 typo: « sodium burning » Same typo in §3.6

**Reply:** The typo error is corrected.

3.5: sodium aerosol size distribution  
Q. You say « …the instrument could not acquire data throughout the experiment… ». When did they stop? The size distribution is given up to 9 minutes. And after? The mass distribution is given at 20 min and 60 min, and you mention in §3.6 that the « aerosol concentration peaked at 25 min ». Could you clarify all these times, the moment when the acquisition stops, what acquisition…?

**Reply:** The aerosol spectrometer (for number concentration measurement) saturated in 10th minute and stopped acquiring the data. Hence, aerosol distribution given for 9 minutes. This is a limitation in measurement from aerosol spectrometer and it can measure maximum particle concentration up to 2\*109 particles/m3.

After that, the size distribution was obtained based on the impactor-based measurement, i.e., mass size distribution. For mass concentration measurement, filter paper sampler was used up to 300 minutes.

3.8 Aerosol modelling and comparison with observations + Future directions  
Q. You explain that « the particles are homogeneously distributed over the simulation domain»: you seem to use a 0D model with which you try to calculate an average concentration evolution with time. Difficult to compare with your non-homogeneous experimental results…

**Reply:** Yes, as correctly pointed out, the 0D model was used for evolution of concentration and median size. In theoretical simulation, the aerosol characteristics (concentration and size) were assumed to be uniform in the 150 m3 chamber. The non-homogeneous distribution cannot be capture by 0D model. Hence, a 3D fluid dynamic model is being developed and simulation will be conducted.

Q. → Do you plan to modify your model?

**Reply:** No, not at this point. The present model is only capable to solve 0D problem. However, 3D CFD based simulation will be carried out in future efforts.

→ How are you going to use your non-homogeneous experimental results? Are you actually planning to develop a 3D CFD code for sodium fires?

**Reply:** Yes, a 3D model is being developed to capture the non-homogeneous evolution of aerosol distribution along with thermal hydraulics during sodium pool fire in a closed chamber.

Dear authors, please submit a revised paper incorporating the comments above by 20 September 2022.