Validation of an I-COSTA code Using the ABCOVE AB5 and AB6 Experiments

Miran Park[a,b], Yoonhee Lee[a,*]
[a]*Dept. of Energy Engineering, Korea Institute of Energy Technology (KENTECH), 21 Kentech-gil, Naju-si, Jeonnam-Gwangu 58330, Republic of Korea*
[b]*Dept. of Applied Plasma and Quantum Beam Engineering, Jeonbuk National University, 567 Baekje-daero, Deokjin-gu, Jeonju-si, Jeonbuk-do 54896, Republic of Korea*
**Corresponding author: yooney@kentech.ac.kr*

***Keywords : I-COSTA validation, Multicomponent Sectional Equations, Aerosol, Source term, ABCOVE Test**

1. Introduction

During a severe accident of a nuclear power plant, fission products released from the reactor coolant system undergo various physical and chemical behaviors in the containment before being released to the environment. The amount, release timing, and chemical forms of fission products released to the environment are evaluated as source term information to assess the effectiveness of accident management strategies. Since a significant fraction of fission products can be transported in the form of aerosols, the prediction of aerosol behavior is important for source term analysis [1].

I-COSTA (In-COntainment Source Term Analysis) has been developed to analyze aerosol behavior in the containment during severe accidents. Aerosol dynamics in I-COSTA are calculated using the multicomponent sectional equation (MSE) methodology. The sectional approach has been widely used for aerosol dynamics calculations, and MAEROS [2] is a representative aerosol model based on this approach. Similar aerosol models have also been implemented in severe accident analysis codes such as CONTAIN [3] and MELCOR [4]. In the previous study [1], I-COSTA was validated with a focus on the coupling between the MSE methodology for aerosol dynamics and the Mason equation for hygroscopic growth. However, the previous study did not independently evaluate the predictive capability of the MSE methodology against experimental aerosol data. Therefore, experimental validation of the MSE methodology is required to evaluate the capability of I-COSTA to predict aerosol behavior.

In this study, the ABCOVE AB5 and AB6 experiments are selected for the experimental validation of I-COSTA. The AB5 experiment considers the behavior of a single-component aerosol (NaOx), while the AB6 experiment considers multicomponent aerosols consisting of NaI and NaOx. The suspended aerosol mass concentration and deposited mass calculated by I-COSTA are compared with the experimental data to evaluate its predictive capability for single- and multicomponent aerosol behavior.

During the AB5 and AB6 experiments, temperature and pressure varied with time. In the current I-COSTA calculations, however, constant temperature and pressure are assumed throughout the calculation. This difference in the thermodynamic conditions may affect the comparison between the experimental and calculated aerosol behaviors. Therefore, temperature and pressure sensitivity analyses are additionally performed to evaluate their effects on the validation results and to examine whether the constant temperature and pressure assumption can explain the discrepancies observed between the experimental and calculated results.

2. Numerical Method and Validation Setup

2.1. Multicomponent Sectional Equations

The aerosol dynamics in I-COSTA are calculated using the multi-component sectional equation (MSE) methodology. In the MSE methodology, the aerosol size domain is divided into a finite number of sections, and the mass concentration of each aerosol component in each section is calculated as a function of time. The MSE methodology accounts for aerosol behaviors including coagulation, deposition, aerosol injection, and interparticle chemical reactions [5]. Interparticle chemical reactions are not considered in the present validation calculations. Based on the conservation of aerosol mass for each component in each section, the MSE governing equation is expressed as follows [1] :

$$\begin{aligned}\frac{dQ_{l,k}}{dt} = &\frac{1}{2}\cdot\sum_{i=1}^{l-1}\sum_{j=1}^{l-1} {}^{1a}\bar{\beta}_{i,j,l}\cdot Q_{j,k}\cdot\bar{Q}_i \\ &+\frac{1}{2}\cdot\sum_{i=1}^{l-1}\sum_{j=1}^{l-1} {}^{1b}\bar{\beta}_{i,j,l}\cdot Q_{i,k}\cdot\bar{Q}_j \\ &-\sum_{i=1}^{l-1}\left[{}^{2a}\bar{\beta}_{i,l}\cdot\bar{Q}_i\cdot Q_{l,k} - {}^{2b}\bar{\beta}_{i,l}\cdot\bar{Q}_l\cdot Q_{i,k}\right] \\ &-\frac{1}{2}\cdot{}^{3}\bar{\beta}_{l,l}\cdot\bar{Q}_l\cdot Q_{l,k} - Q_{l,k}\cdot\sum_{i=l+1}^{m}{}^{4}\bar{\beta}_{i,l}\cdot\bar{Q}_i \\ &+\bar{S}_{l,k} - \bar{R}_{l,k}\cdot Q_{l,k},\end{aligned} \quad (1)$$

where

$Q_{l,k}$: mass concentration of aerosol particles of component *k* in section *l*,

$\bar{Q}_l = \sum_{k=1}^{n_{comp}} Q_{l,k}$,

${}^{1a}\bar{\beta}_{i,j,l}$, ${}^{1b}\bar{\beta}_{i,j,l}$: coagulation rate of the aerosol particles in sections lower than l forming an aerosol particle in section l,

n_{comp} : number of components of the aerosol particles considered in the multicomponent sectional equations,

${}^{2a}\bar{\beta}_{i,j,l}$: coagulation rate of the aerosol particles in section l and sections lower than l forming an aerosol particle larger than those in section l,

${}^{2b}\bar{\beta}_{i,j,l}$: coagulation rate of the aerosol particles in section l and sections lower than l forming an aerosol particle remaining in section l,

${}^{3}\bar{\beta}_{i,l}$: intra-sectional coagulation rate of the aerosol particles in section l forming an aerosol particle larger than those in section l,

${}^{4}\bar{\beta}_{i,l}$: coagulation rate of the aerosol particles in section l forming an aerosol particle larger than those in section l,

$\bar{S}_{l,k}$: injection rates of the aerosol particles in section l,

$\bar{R}_{l,k}$: removal rates of the aerosol particles in section l via deposition,

Eq. (1) can be simplified with a constraint on the mass of aerosol particles. It is rewritten as

$$\begin{aligned}\frac{dQ_{l,k}}{dt} &= \frac{1}{2}\cdot\sum_{l=1}^{l-2} {}^{1a}\bar{\beta}_{i,l-1,l}\cdot Q_{l-1,k}\cdot\bar{Q}_i \\ &+\frac{1}{2}\cdot\sum_{l=1}^{l-2} {}^{1b}\bar{\beta}_{i,l-1,l}\cdot Q_{i,k}\cdot\bar{Q}_{l-1} \\ &+\frac{1}{2}\cdot\sum_{j=1}^{l-2} {}^{1a}\bar{\beta}_{l-1,j,l}\cdot Q_{j,k}\cdot\bar{Q}_l \\ &+\frac{1}{2}\cdot\sum_{j=1}^{l-2} {}^{1b}\bar{\beta}_{l-1,j,l}\cdot Q_{l-1,k}\cdot\bar{Q}_j \\ &+\frac{1}{2}\cdot\left[{}^{1a}\bar{\beta}_{l-1,l-1,l}+{}^{1b}\bar{\beta}_{l-1,l-1,l}\right]\cdot Q_{l-1,k}\cdot\bar{Q}_{l-1} \\ &-\sum_{i=1}^{l-1}\left[{}^{2a}\bar{\beta}_{i,l}\cdot\bar{Q}_i\cdot Q_{l,k}-{}^{2b}\bar{\beta}_{i,l}\cdot\bar{Q}_l\cdot Q_{i,k}\right] \\ &-\frac{1}{2}\cdot{}^{3}\bar{\beta}_{l,l}\cdot\bar{Q}_l\cdot Q_{l,k}-Q_{l,k}\cdot\sum_{i=l+1}^{m}{}^{4}\bar{\beta}_{i,l}\cdot\bar{Q}_i \\ &+\bar{S}_{l,k}-\bar{R}_{l,k}\cdot Q_{l,k}.\end{aligned} \quad (2)$$

Eq. (2) is used to calculate the temporal evolution of aerosol mass concentration in each section and component.

2.2. Validation Setup Using ABCOVE experimental data

The ABCOVE AB5 and AB6 experimental data are used for the validation of the MSE implemented in I-COSTA. The AB5 experiment was conducted with NaOx aerosol, while the AB6 experiment was conducted using NaI and NaOx aerosols. The suspended aerosol mass concentration and deposited mass measured in the experiments were compared with the corresponding I-COSTA calculation results.

The input conditions for the I-COSTA calculations are determined based on the experimental and modeling conditions reported in the MELCOR 1.8.2 assessment [6]. The aerosol size parameters used for the AB5 and AB6 calculations are summarized in Table 1. The aerosol dynamic parameters commonly applied to the I-COSTA calculations are summarized in Table 2. Note that thermophoretic deposition is not activated in the present AB5 and AB6 validation calculations. Accordingly, wall temperature and the transient gas–wall temperature gradient were not used in the aerosol deposition calculations.

Table 1. Aerosol Size Parameters and Particle Properties Used for AB5 and AB6 Calculations

Parameter	**AB5 NaOx**	**AB6 NaI**	**AB6 NaOx**
MMD [m]	5.0E-07	5.44E-07	5.0E-07
GSD	1.5	1.55	2.0
Lower bound diameter [m]	1.0E-08	1.0E-07	1.0E-07
Upper bound diameter [m]	1.0E-05	1.0E-04	1.0E-04
Particle density [kg/m³]	2.50E+03	3.67E+03	2.45E+03
Number of sections	20		
Section spacing	Logarithmic		

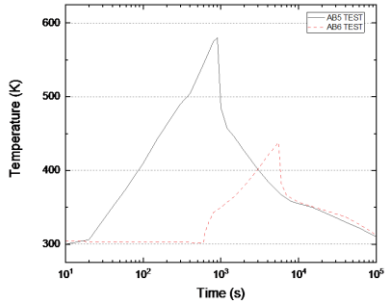
Note: The particle-size ranges and densities were adopted from the MELCOR 1.8.2 assessment and its input decks [6], which were based primarily on the original AB5 and AB6 test reports [7-8]. Each size range was discretized into 20 logarithmically spaced sections.

Table 2. Aerosol Dynamic Constants Used in I-COSTA Calculations [6]

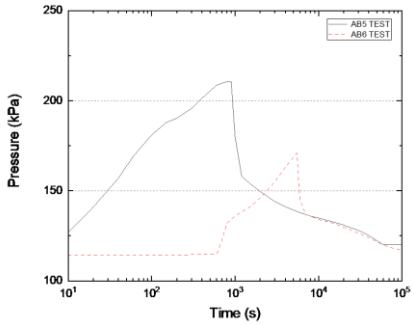
Parameters	Values	
Dynamic Shape Factor	1.5	[-]
Agglomeration Shape Factor	2.25	[-]
Slip Coefficient	1.37	[-]
Particle Sticking Coefficient	1.0	[-]
Turbulence Dissipation	1.0E-03	m^2/s^3
Diffusion Boundary Layer Thickness	1.0E-05	m

During the AB5 and AB6 experiments, temperature and pressure varied with time, whereas the current version of I-COSTA assumes constant thermodynamic conditions during each calculation. For the main validation, calculations were performed using the maximum temperature–pressure (Tmax-Pmax) and minimum temperature–pressure (Tmin-Pmin)

conditions as representative extreme constant-condition cases to evaluate the range of predictions associated with this assumption. The effects of temperature and pressure were subsequently examined separately in Section 3.3, where the average temperature and pressure condition (Tave-Pave) was used as the reference case for the sensitivity analysis.



(a) Temperature



(b) Pressure

Fig. 1. Temperature and pressure histories during the ABCOVE AB5 and AB6 experiments

3. Results and Discussion

3.1. AB5 Validation Results

The AB5 experiment was used to evaluate the capability of I-COSTA to predict the suspended aerosol mass concentration and deposited mass for a single-component NaOx aerosol. Figs. 2 and 3 compare the I-COSTA calculations with the AB5 experimental data.

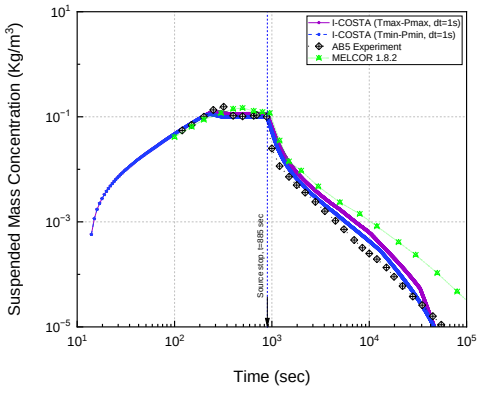


Fig. 2. Suspended aerosol mass concentration for AB5: experiment, I-COSTA, and MELCOR 1.8.2.

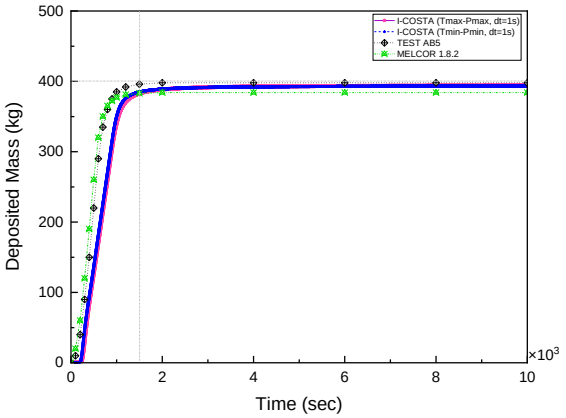


Fig. 3. Deposited aerosol mass for AB5: experiment, I-COSTA, and MELCOR 1.8.2.

As shown in Fig. 2, I-COSTA reproduces the overall transient behavior of the suspended aerosol mass concentration, including the increase during aerosol injection and the subsequent decrease after the injection was terminated. The measured peak concentration was approximately 1.55E-01 kg/m³, while the calculated peak concentrations were 1.25E-01 and 1.10E-01 kg/m³ under the Tmax-Pmax and Tmin-Pmin conditions, respectively. I-COSTA therefore underestimates the peak concentration by approximately 19% and 29%, respectively. After the aerosol injection is terminated, the calculated concentration decreases more slowly than the experimental data. At approximately 10,000 s, the measured concentration was 2.50E-04 kg/m³, while the calculated concentrations were 6.31E-04 and 4.30E-04 kg/m³ under the Tmax-Pmax and Tmin-Pmin conditions, respectively. These results show that I-COSTA reproduces the overall transient behavior observed in the AB5 experiment, while discrepancies remains in the magnitude of the suspended aerosol mass concentration.

Fig. 3 compares the deposited mass calculated by I-COSTA with the AB5 experimental data. The deposited mass increases rapidly during the early stage of the experiment and gradually approached a plateau. I-COSTA reproduces this overall trend, although the increase in deposited mass is slower than that observed in the experiment during the early stage. At the end of the experiment, the measured deposited mass is approximately 400 kg, while the calculated values are approximately 394 and 393 kg under the Tmax-Pmax and Tmin-Pmin conditions, respectively. Thus, despite the discrepancy in the transient deposition behavior, the final deposited mass is predicted within approximately 2% of the experimental value. Because the present comparison is based on the final total deposited mass, this agreement should be interpreted as validation of the total deposited aerosol inventory. It does not by itself demonstrate accurate prediction of the deposition transient or of the individual deposition mechanisms.

Overall, the AB5 validation results show that I-COSTA reproduces the general evolution of both suspended and deposited aerosol mass for a single-component aerosol. However, discrepancies are

observed in the magnitude and temporal evolution of the suspended aerosol concentration and in the early-stage deposition behavior, whereas the final deposited mass is predicted within approximately 2% of the experimental value. These results indicate that agreement in the final deposited mass alone is not sufficient to demonstrate accurate prediction of the transient aerosol behavior. The possible effects of the constant temperature and pressure assumption on these discrepancies are evaluated in Section 3.3.

3.2. AB6 Validation Results

The AB6 experiment is used to evaluate the capability of I-COSTA to predict the behavior of multicomponent aerosols consisting of NaI and NaOx. Fig. 4 compares the suspended aerosol mass concentrations calculated by I-COSTA with the AB6 experimental data. And Fig. 5 shows the time-dependent deposited masses of NaI and NaOx calculated by I-COSTA.

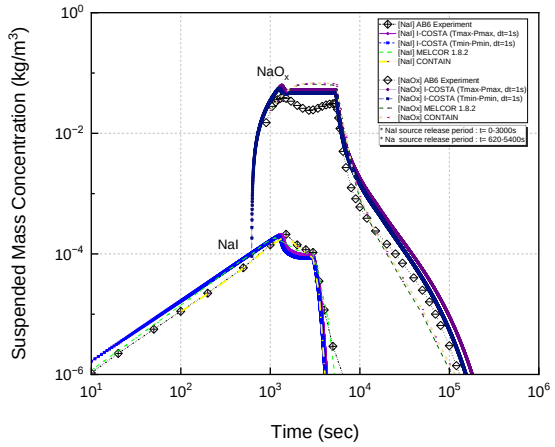


Fig. 4. Suspended aerosol mass concentrations for AB6: experiment, I-COSTA, and MELCOR 1.8.2.

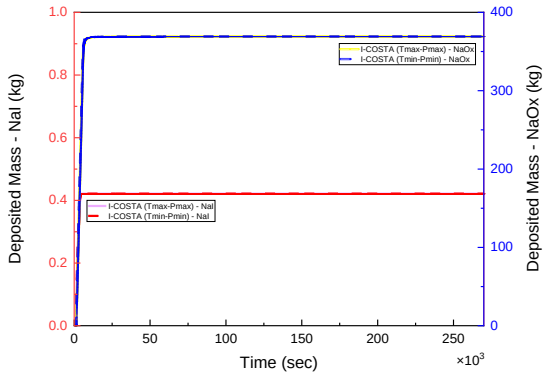


Fig. 5. Deposited NaI and NaOx masses calculated by I-COSTA for AB6.

As shown in Fig. 4, I-COSTA reproduced the overall transient behavior of both NaI and NaOx, including the increase during aerosol injection and the subsequent decrease after the source release was terminated. For NaI, the calculated suspended mass concentrations were generally consistent with the experimental data in both the transient trend and concentration magnitude. In contrast, the NaOx concentration was overpredicted during the period following aerosol injection and remained higher than the experimental data during the subsequent decrease. Therefore, the agreement between the experiment and calculation was dependent on the aerosol species, with better agreement observed for NaI than for NaOx.

As shown in Fig. 5, the deposited masses increase during the early stage of the experiment and gradually approached constant values. In the AB6 experiment, the total deposited masses of NaI and NaOx are approximately 0.417 and 372 kg, respectively, based on the sum of the plated and settled aerosol masses reported in Ref. [6]. I-COSTA predicted final deposited masses of approximately 0.421 kg for NaI and 368 kg for NaOx, corresponding to differences of approximately 1.1% and 1.2% from the experimental values, respectively. Similarly, the agreement in the final total deposited masses does not imply that the plated and settled aerosol masses, their spatial distribution, or the individual deposition mechanisms are accurately reproduced. These quantities are not separately evaluated in the present validation.

Overall, the AB6 validation results show that I-COSTA reproduces the general behavior of multicomponent aerosols, while the prediction accuracy of the suspended aerosol mass concentration depends on the aerosol species. In particular, a larger discrepancy is observed for the suspended NaOx concentration, whereas the final deposited masses of both NaI and NaOx agree well with the experimental values. The quantitative validation results for the AB5 and AB6 experiments are summarized in Table 4.

Table 4. Summary of I-COSTA Validation Results

Test	Parameter	Exp.	I-COSTA
AB5	Peak Conc. (kg/m³)	1.55E-01	1.10~1.25E-01
	Final deposited mass (kg)	~400	393~394
AB6	Peak conc. (NaI) (kg/m³)	2.11E-04	1.96~2.09E-04
	Peak conc.(NaOx) (kg/m³)	3.50E-02	5.53~6.25E-02
	Final deposited mass (NaI) (kg)	0.417	0.421
	Final deposited mass (NaOx) (kg)	372	368

3.3. Temperature and Pressure Sensitivity Analysis

As discussed in Sections 3.1 and 3.2, discrepancies are observed between the experimental and calculated suspended aerosol mass concentrations, whereas the

final deposited masses are generally well reproduced. In the I-COSTA calculations, constant temperature and pressure conditions are assumed for each experiment, although both parameters vary with time during the AB5 and AB6 tests, as shown in Fig. 1. Therefore, sensitivity calculations are performed to evaluate the effects of the assumed temperature and pressure conditions on the suspended aerosol mass concentration.

Five calculation cases are considered using the minimum, average, and maximum temperatures and pressures measured during the AB5 and AB6 experiments. The average temperature and pressure condition (Tave-Pave) is used as the base case, while the temperature or pressure is independently varied to its minimum or maximum value. The calculation conditions for the sensitivity analysis are summarized in Table 5. Note that in this section, Tave-Pave is used only as the reference condition for the sensitivity analysis and should be distinguished from the bounding Tmax-Pmax and Tmin-Pmin cases used in the main validation calculations. The AB6 temperature conditions were determined based on the Test AB6 conditions reported in the MELCOR 1.8.2 assessment and its input deck [6].

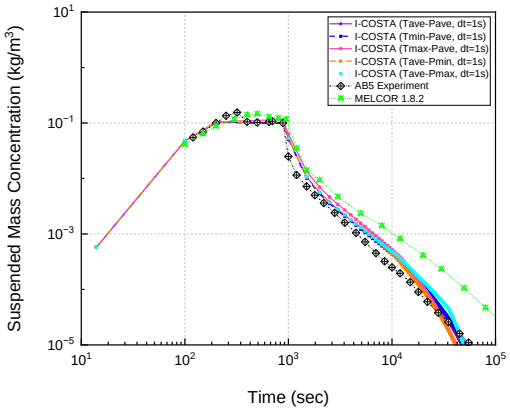
Table 5. Temperature and Pressure Conditions for Sensitivity Analysis

	AB5		AB6	
Case*	**Temp. (K)**	**Pres. (Pa)**	**Temp. (K)**	**Pres. (Pa)**
Tave - Pave	371.73	1.37E+5	438.25	1.14E+5
Tmin - Pave	298.55	1.37E+5	298.00	1.14E+5
Tmax - Pave	577.35	1.37E+5	483.25	1.14E+5
Tave - Pmin	371.73	9.77E+4	438.25	1.00E+5
Tave - Pmax	371.73	2.13E+5	438.25	1.70E+5

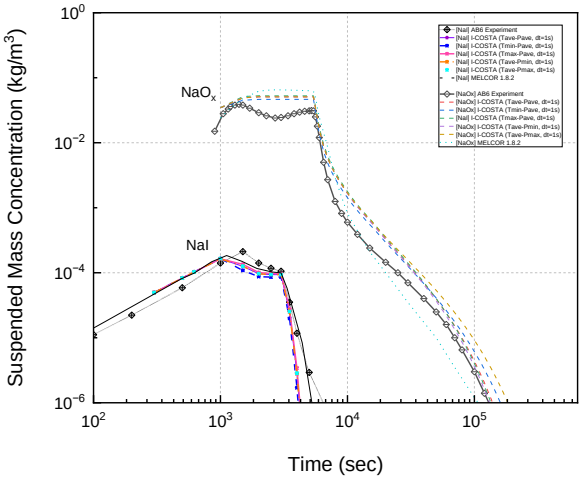
* Tave, Tmin, and Tmax denote the average, minimum, and maximum temperatures, respectively; Pave, Pmin, and Pmax denote the corresponding pressure conditions.

Fig. 6 compares the suspended aerosol mass concentrations calculated under the five temperature and pressure conditions. For AB5, the overall transient behavior was similar among all sensitivity cases. However, the maximum temperature condition (Tmax-Pave) resulted in a higher peak suspended mass concentration than the base case, whereas the effects of the other temperature and pressure conditions were relatively small. For AB6, the NaI peak concentration showed relatively small changes when temperature and pressure were varied independently from the reference condition. The NaOx peak concentration exhibited a relatively larger response to temperature variation, whereas the changes caused by pressure variation were small in the one-at-a-time sensitivity cases.

The effects of temperature and pressure on the peak suspended mass concentrations are quantitatively summarized in Table 6. For AB5, the peak concentration under the Tmax-Pave condition increases by approximately 10% compared with the base case, whereas the differences for the other conditions are approximately 1%. For AB6, the peak NaI concentration varies by approximately 1% or less for all sensitivity cases. In contrast, the peak NaOx concentration decreases by approximately 9% under the Tmin-Pave condition and increases by approximately 4% under the Tmax-Pave condition. Variations in pressure result in changes of approximately 1% in the peak concentration.



(a) AB5 test



(b) AB6 test

Fig. 6. Suspended aerosol mass concentrations for the temperature and pressure sensitivity cases

Table 6. Sensitivity of Peak Suspended Mass Concentration to Temperature and Pressure

Case	AB5 NaOx	AB6 NaI	AB6 NaOx
Base	1.03E-01 (-)	1.64E-04 (-)	5.09E-02 (-)
Tmin-Pave	1.03E-01 (~1%)	1.65E-04 (~1%)	4.66E-02 (-9%)
Tmax-Pave	1.13E-01 (+10%)	1.64E-04 (~1%)	5.29E-02 (+4%)
Tave-Pmin	1.03E-01 (~1%)	1.64E-04 (~1%)	5.09E-02 (~1%)
Tave-Pmax	1.03E-01 (~1%)	1.64E-04 (~1%)	5.09E-02 (~1%)

Although the suspended aerosol mass concentration showed some sensitivity to temperature, particularly for AB5 and NaOx in AB6, the magnitude of these changes is insufficient to account for the discrepancies observed in the validation results. For AB5, the measured peak

suspended mass concentration is approximately 1.55E-01 kg/m^3, whereas the calculated value under the base condition is approximately 1.03E-01 kg/m^3. Increasing the temperature to its maximum value increases the calculated peak concentration to approximately 1.13E-01 kg/m^3, which reduces the discrepancy but does not reproduce the experimental value. Similarly, for NaOx in AB6, the minimum temperature condition reduces the calculated peak concentration from approximately 5.09E-02 to 4.66E-02 kg/m³, approaching the experimental value of approximately 3.50E-02 kg/m³ but still resulting in an overprediction.

The final deposited masses show negligible differences among the sensitivity cases. Therefore, within the range of temperature and pressure conditions considered in this study, the constant temperature and pressure assumption affects the prediction of the suspended aerosol mass concentration to some extent but has little effect on the final deposited mass. In the present one-at-a-time sensitivity analysis, temperature produced a greater change in the peak suspended aerosol concentration than pressure. However, the sensitivity analysis indicates that the discrepancies in the suspended aerosol mass concentration cannot be explained solely by the constant temperature and pressure assumption, suggesting that other factors may also contribute to the remaining differences between the experimental and calculated results.

4. Conclusions

In this study, I-COSTA was validated against the ABCOVE AB5 and AB6 experiments to evaluate its capability to predict single- and multicomponent aerosol behavior. The suspended aerosol mass concentration and deposited mass were compared with the experimental data, and additional sensitivity calculations were performed to evaluate the effects of the constant temperature and pressure assumptions used in I-COSTA.

For the AB5 experiment, I-COSTA reproduced the overall transient behavior of the suspended NaOx aerosol, although discrepancies were observed in the peak concentration and the subsequent decrease after aerosol injection. The final deposited mass was predicted within approximately 2% of the experimental value. For the AB6 experiment, the suspended NaI concentration was generally well reproduced, whereas a larger discrepancy was observed for NaOx. In contrast, the final total deposited masses of both NaI and NaOx agreed with the experimental values within approximately 2%. These results demonstrate that I-COSTA can reproduce the overall aerosol behavior and final deposited mass under both single- and multicomponent aerosol conditions, while discrepancies remain in the prediction of the transient suspended aerosol concentration.

The one-at-a-time sensitivity analysis showed that variations in temperature produced larger changes in the peak suspended aerosol mass concentration than variations in pressure. The largest changes in the peak concentration were approximately 10% for AB5 and 9% for NaOx in AB6, whereas the effect of pressure was relatively small. However, these variations were insufficient to account for the discrepancies observed between the experimental and calculated suspended aerosol concentrations. The final deposited mass was nearly insensitive to the temperature and pressure conditions considered in the present analysis. Therefore, the discrepancies in the suspended aerosol behavior cannot be explained solely by the constant temperature and pressure assumptions.

Overall, the present validation demonstrates the applicability of I-COSTA to the prediction of aerosol transport behavior while identifying remaining discrepancies in transient suspended aerosol predictions. The agreement in the final deposited mass should therefore be interpreted as validation of the total deposited aerosol inventory only. The transient deposition behavior, spatial distribution of deposited aerosols, and individual deposition mechanisms were not independently validated in the present study. Further investigation of the factors contributing to the remaining discrepancies in the suspended aerosol behavior is required to improve the predictive capability of I-COSTA.

ACKNOWLEDGEMENTS

This research was also supported by the National Research Foundation of Korea (NRF) grant funded by the ministry of Science and ICT (MSIT), Republic of Korea (RS-2023-00261295).

REFERENCES

[1] M. Park and Y. Lee. (2025). Verification and Validation of I-COSTA Code for Analysis of the Behavior of Aerosol Particles with High Hygroscopicity in the Containment. Journal of Energy Engineering **34**(1): 15-30.

[2] Gelbard, F. (1982). MAEROS user manual.[LMFBR], Sandia National Labs., Albuquerque, NM (USA).

[3] Murata, K. K., et al. (1997). Code manual for CONTAIN 2.0: A computer code for nuclear reactor containment analysis.

[4] Humphries, L. L., et al. (2015). MELCOR Computer Code Manuals Volume 3: MELCOR Assessment Problems [Draft]. United States, Sandia National Laboratories (SNL-NM), Albuquerque, NM (United States).

[5] Gelbard, F., et al. (1980). Sectional representations for simulating aerosol dynamics. Journal of Colloid and Interface Science **76**(2): 541-556.

[6] Souto, F. J., et al. (1994). MELCOR 1.8.2 assessment: Aerosol experiments ABCOVE AB5, AB6, AB7, and LACE LA2. United States, Sandia National Labs., Albuquerque, NM (United States).

[7] Hilliard, R. K., et al. (1983). Results and code predictions for ABCOVE aerosol code validation - Test AB5. United States, Hanford Engineering Development Lab., Richland, WA (United States).

[8] Hilliard, R. K., et al. (1984). Results and code predictions for ABCOVE (aerosol behavior code validation and evaluation) aerosol code validation: Test AB6 with two

aerosol species. [LMFBR]. United States, Hanford Engineering Development Lab., Richland, WA (USA).
[9] De Luna, B., & Phillips, J. (2024). Benchmarking MELCOR's NAC Package to ABCOVE Tests AB5 and AB6. United States, Sandia National Laboratories (SNL-NM), Albuquerque, NM (United States).