

APPENDIX A

In the following, we describe the method and results used to estimate the time to volatilization of single-component particles in this paper. The calculation method described below is based on the method of Hinds (1999).

According to Hinds (1999), the evaporation rate of a single component particle of size D_p can be expressed by Eq. A1:

$$\frac{dD_p}{dt} = \frac{4D_v M}{R\rho D_p} \left(\frac{P}{T} - \frac{P_s}{T_s} \right) \varphi , \quad (\text{A1})$$

where D_v is the diffusion coefficient of volatilized molecules in air, M is the mass of molecules per mol, R is the gas constant, ρ is the density of molecules in the liquid, P is the partial pressure of molecules far from the particle in the system, T is the temperature of the system, P_s is the partial pressure of molecules at the particle surface, T_s is the temperature at the particle surface, and φ is Fuch's correction factor. Assuming $P = 0$ and $T_s = T$, Eq. A1 can be expressed as Eq. A2 (Fujitani et al., 2012):

$$\frac{dD_p}{dt} = \frac{4D_v M}{R\rho D_p T} (-P_s) \varphi . \quad (\text{A2})$$

The P_s on the surface of the particles in the right-hand side of Eq. A2 is calculated by the equation for vapor pressure at T obtained from the Clausius–Clapeyron equation multiplied

by the Kelvin ratio (K_R):

$$P_s = K_R P_v \exp \left[-\Delta H_v \left(\frac{1}{T} - \frac{1}{298} \right) \right] , \quad (\text{A3})$$

where P_v is the saturation vapor pressure at 298 K, ΔH_v is the evaporation enthalpy at 298 K,

and K_R is the coefficient of the increase in vapor pressure at the surface of the microparticles

due to the Kelvin effect, as shown in Eq. A4:

$$K_R = \exp \left(\frac{4\gamma M}{R\rho D_p T} \right). \quad (\text{A4})$$

Fuch's correction factor on the right-hand side of Eq. A2 is expressed as Eq. A5:

$$\varphi = \frac{2\lambda + D_p}{D_p + 5.33(\lambda^2/D_p) + 3.42\lambda} , \quad (\text{A5})$$

where λ is the mean free path of a molecule in air at T . In this study, we used the value of the mean free path of nitrogen molecules as an approximation.

The values of D_v , ρ , P_v , and ΔH_v for five organic compounds (adipic acid, phthalic acid, *meso*-erythritol, *cis*-pinonic acid, and terephthaldialdehyde) were calculated using the SPARC online calculator (Hilal et al., 2003). The literature value of the surface tension of dioctyl phthalate (0.0311 N m⁻¹; Yaws, 2014) was used as a substitute for the surface tension values of the five organics.

As an example, the calculation results for adipic acid particles with a diameter of 350 nm are shown in Fig. A1. The time to evaporation of adipic acid particles was 53 s, 2.6 s, 51 ms, and 5.1 ms at the system temperatures of 50°C, 70°C, 100°C, and 120°C, respectively. At 58°C, the time to evaporation of 350-nm adipic acid particles was the same as the residence time of the TD system. Similar calculations were performed for organic materials other than adipic acid, and the temperature at which the time for evaporation of 350-nm particles was the same as the residence time of the TD system was investigated. The results are shown in Table 2 in the main text.

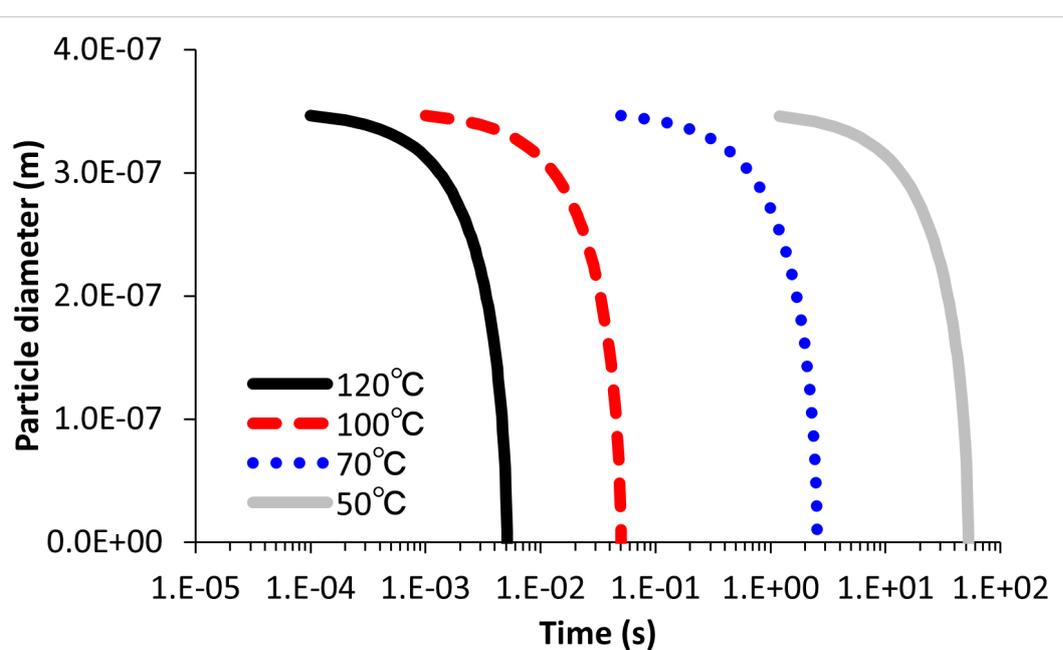


Fig. A1 Temporal profiles of diameter calculated for 350-nm adipic acid particles at 50°C, 70°C, 100°C, and 120°C.

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