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Determining the ultraviolet radiation dose experienced by aerosols using ultraviolet-sensitive dyes

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S1. Estimating the cutoff Stokes diameter of the designed impactor.

In an impactor, the parameter that governs collection efficiency is the Stokes number (Fuchs and Davies, 1989), which is defined as the ratio of the particle stopping distance at the average nozzle exit velocity U to the half the jet diameter D_j:

$$Stk = \frac{\tau U}{D_j/2} = \frac{\rho_p d_p^2 U C_c}{9\eta D_j} \quad \text{(S1-1)}$$

Where ρ_p = the particle density

D_p = particle Stokes diameter

C_c = Cunningham slip factor

U = mean velocity in the jet

η = gas viscosity

D_j = jet diameter

The cutoff diameter d_{50} corresponds to a single Stokes number Stk_{50}, which gives 50% collection efficiency. According to equation (S1-1), the cutoff diameter in terms of the values of Stk_{50} can be expressed as:

$$d_{50}\sqrt{C_C} = \left[\frac{9\eta D_j (Stk_{50})}{\rho_p U}\right]^{1/2} \quad \text{(S1-2)}$$

By writing the jet velocity U in equation S1-2 as the ration of the jet flow rate Q to the jet cross-sectional area. For a round jet impactor (Stk_{50} =0.24, when the ratio of the jet-to-plate distance to the jet diameter exceeds 1.0)(Hinds, 1999), the equation (S1-2) can also be expressed as:

$$d_{50}\sqrt{C_C} = \left[\frac{9\pi\eta {D_j}^3 (Stk_{50})}{4\rho_p Q}\right]^{1/2} \quad \text{(S1-3)}$$

The Cunningham slip factor is a function of particle diameter. To simplify the calculation, we applied the count median stokes diameter d_{CMD}, which determined by the ELPI (electrostatic low-pressure impactor) to estimate the Cunningham slip factor using the following equation (S1-4):

$$C_C(p, d_{CMD}) = 1 + \frac{2\lambda_g(p)}{d_{CMD}}\left(A_1 + A_2 \cdot \exp\left(-A_3 \cdot \frac{d_{CMD}}{2\lambda_g(p)}\right)\right) \quad \text{(S1-4)}$$

Where A_1, A_2, A_3 are given by Rader (Rader, 1990) as A_1 = 1.207, A_2 = 0.440 and A_3 = 0.78. λ_g is the minimum free path length of gas molecules (nitrogen in this study) as function of impactor pressure p.

Table S1 summarizes the parameters used to determine the cutoff diameter for the impactor used in this work.

Particle density (DEHS)	ρ_p	912	$kg \cdot m^{-3}$
Gas viscosity (N_2)	η	1.78E-05	Pa·s
Circular jet diameter	D_j	2.0E-03	m
Stokes number (circular jet)	Stk_{50}	0.24	-
Impactor pressure	p	0.22	atm
Gas mean free path @1atm	λ_0	67.4	nm
Gas mean free path @impactor	λ_g	306.4	nm
Count median Stokes diameter (ELPI)	d_{CMD}	505	nm
Cunningham slip factor	$C_c(p,d_{CMD})$	2.75	-
Inlet flow rate q_1@1atm	q_1	0.78	$L \cdot min^{-1}$
Inlet flow rate q_2 @1atm	q_2	2.26	$L \cdot min^{-1}$
Inlet flow rate q_3 @1atm	q_3	8.86	$L \cdot min^{-1}$
Jet flow rate Q_1	Q_1	3.55	$L \cdot min^{-1}$
Jet flow rate Q_2	Q_2	10.27	$L \cdot min^{-1}$
Jet flow rate Q_3	Q_3	40.27	$L \cdot min^{-1}$
Cutoff diameter @ inlet flow q_1	$d_{50,1}$	1280	nm
Cutoff diameter @ inlet flow q_2	$d_{50,2}$	750	nm
Cutoff diameter @ inlet flow q_3	$d_{50,3}$	379	nm

Reference

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