Characterization of a Thermal Denuder for the Estimation of Volatility Parameters of Laboratory Generated Aerosols.

Early Career Scientist

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Abstract:
In this study, a new KNU thermal denuder was developed and characterized in detail. The temperature profile was uniform with relatively higher exit temperatures as compared to previous studies. Temperature ramping rate was $-14.3^\circ\text{C min}^{-1}$ for a set value in the range of 25$^\circ\text{C}$-250$^\circ\text{C}$. Particle losses in thermal denuder were due to diffusional and thermophoretic losses at room and higher temperatures, respectively. Furthermore, integrated volume method was used to determine saturation pressure ($P_{\text{sat}}^0$) at 25$^\circ\text{C}$ and enthalpy of vaporization ($\Delta H_v$) of organic aerosols (single component and binary mixtures) using volatility profile data generated by coupling thermal denuder and scanning mobility particle sizer. For cis-pinonic acid, (1S)-(+-)ketopinic acid, (1R)-(+-)nopinone, phthalic acid, catechol, benzoic acid, and o-cresol determined $\Delta H_v$ and $P_{\text{sat}}^0$ were 81.5 kJ mol$^{-1}$, 41.2 kJ mol$^{-1}$, 36.4 kJ mol$^{-1}$, 45.1 kJ mol$^{-1}$, 58.8 kJ mol$^{-1}$, 75.2 kJ mol$^{-1}$, and 39.8 kJ mol$^{-1}$ and 0.24 x 10$^{-5}$ Pa, 0.65 x 10$^{-5}$ Pa, 1.67 x 10$^{-5}$ Pa, 1.15 x 10$^{-4}$ Pa, 6.55 Pa, 0.18 Pa, and 12.47 Pa, respectively. For the case of binary mixtures of benzoic acid and o-cresol, catechol and phthalic acid, cis-pinonic acid and nopinone, and ketopinic acid and nopinone, the values of $P_{\text{sat}}^0, \Delta H_v$ and $P_{\text{sat}}^0$ for high and low volatile components were estimated using two product model and were within 10% to 38% of single component values. In addition, estimated $\Delta H_v$ and $P_{\text{sat}}^0$ using Thermal Denuder were also compared with those determined using Thermogravimetric Analysis.