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Phase-transition of ambient PM_{2.5} samples collected in the Po Valley: deliquescence and crystallization relative humidity measured in Aerosol Exposure Chamber

The aerosol hydration level affects the aerosol optical properties [1] and its corrosion capability on metallic surfaces [2]. In this respect, corrosion prevention in Data Center basing on aerosol properties could produce energy-saving benefits.

In this work, PM_{2.5} samples collected in the Po Valley were subject to an innovative analysis method to characterize mutual deliquescence and crystallization RH (MDRH and MCRH). PM_{2.5} conductivity was measured while varying RH in a new Aerosol Exposure Chamber (AEC). Constant temperature was kept in AEC and RH steps were of 1%. PM_{2.5} samples were also chemically analysed by ionic chromatography (IC).

Seasonal variability of MDRH and MCRH was identified. In particular, MDRH in wintertime was $60.1 \pm 1.1\%$ while in summer was $71.8 \pm 0.9\%$. MCRH was recognized at $46.9 \pm 1.1\%$ in winter and at $64.9 \pm 1.1\%$ in summer. Thus, hysteresis amplitudes between the two seasons were significantly different and they were quantified to be $13.2 \pm 1.1\%$ in winter and $7.3 \pm 0.7\%$ in summer. IC analysis showed that in Milan sulphate compounds dominate the PM_{2.5} ionic fraction in summer ($17.8 \pm 1.5\%$) while nitrates compounds dominate in winter ($21.5 \pm 3.6\%$). These data allow us to understand the seasonal behaviour of MDRH and MCRH as $(\text{NH}_4)_2\text{SO}_4$ and NH_4NO_3 are responsible of increasing and decreasing of critical RH, respectively.

Considering the RH values in Milan during 2006-2013, the measured MDRH and MCRH allowed to estimate that the aerosol is hydrated for 33% of time in winter and summer seasons. Moreover, an innovative application of these data for Data Center cooling application will be discussed: briefly the knowledge of MDRH and MCRH allowed to save in one year 81% of energy with a CO₂ emission-saving of 80 kt in the newly constructed Eni Green Data Center (http://www.eni.com/green-data-center/it_IT/pages/home.shtml) [2].

[1] Martin ST(2000), Chem Rev 100:3403-3454

[2] Ferrero L et al.(2013), Environ Sci Technol. 47:3856-64

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