Sulphuric Acid Aerosol Formation in Industrial Processes – Simulation and CPC measurement at a Pilot Plant

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The formation of sulphuric acid aerosols is a phenomenon which emerges frequently in industrial processes. An important domain is for example the absorption-based flue gas cleaning in power plants (wet flue gas desulfurization). Problems such as corrosion and the occurrence of a distinct "blue plume" may arise due to the aerosol formation. The problem evolves in particular in the presence of $DeNO_X$-systems with selective catalytic reduction (SCR). The resulting aerosol droplets remain sub-micron even after coagulation and are difficult to precipitate.

The simulation tool AerCoDe has been developed at the Institute for Technical Thermodynamics and Refrigeration to predict aerosol formation initiated by heterogeneous (Wix, 2008) as well as homogeneous nucleation (Wix *et al*, 2010). In sulphuric acid – water systems homogeneous nucleation has to be considered. The reason for this is the occurrence of high supersaturations as a result of the extreme phase equilibrium of this binary system. The simulation yields high number concentrations up to 10^{10} 1/cm³ (Wix *et al*, 2010). The number concentration is slightly lower when the parameterisation of Vehkamäki et al (2003) is used to take the formation of hydrate clusters into account (Figure 1). The resulting number concentrations are high even for low inlet concentrations of H_2SO_4 combined with very small diameters (<20 nm) of the aerosol droplets.

Additional polydisperse coagulation calculations show the rapid decrease in number concentrations to 10^8 1/cm³. Due to the higher number concentrations and smaller droplets the coagulation has a larger influence on the number concentration for small sulphuric acid concentrations in the flue gas (Figure 1).

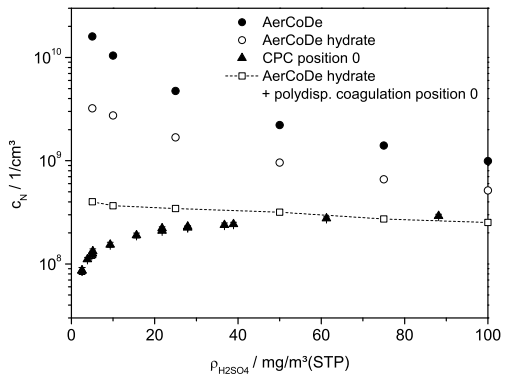

Figure 1 Total number concentrations in the absorption column outlet as a function of the H_2SO_4 inlet concentration. Simulation with AerCoDe and CPC measurements

The experiments at the pilot plant and the measurements with the condensational particle counter (CPC) confirm the high number concentrations in the order of magnitude of 10^8 1/cm³ (Figure1 and 2). At lower sulphuric acid concentrations remains a gap between simulations and experiments which can be explained partly by deposition and by the cut-off of the measurement device at smaller droplet sizes.

Experiments with varying number concentrations of soot particles in the pilot plant demonstrate the occurrence of homogeneous nucleation even in the presence of ~$5*10^6$ 1/cm³ foreign nuclei (compared to ~$2*10^4$ 1/cm³ in low soot mode). As a result, high number concentrations of sulphuric acid aerosol droplets with very small droplet diameters are present even at high soot concentrations.

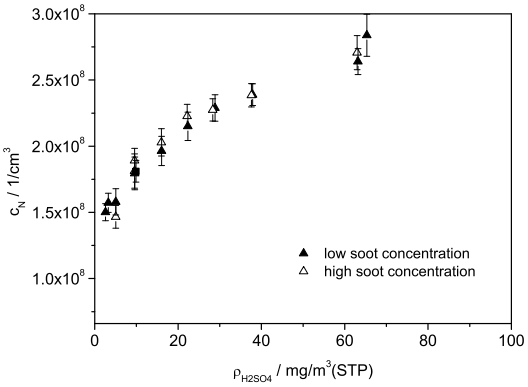

Figure 2 Total number concentrations in the absorption column outlet at low and high soot concentrations (CPC measurements)

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