Effects of induced gas flow on electrospray dynamics

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Keywords: electrospray, numerical simulation, induced gas flow, spray dynamics.
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Electrosprays are constituted of highly charged micro drops created by the action of electrostatic forces. Because these aerosol particles move with a net velocity relative to the surrounding gas, their reactive drag force on the gas causes the gas to flow. We are investigating the extent to which this gas motion influences electrospray droplet evaporation and vapor concentration, as well as the electrospray dynamics.

Considering non volatile sprays initially, we have devised a numerical scheme based on the vorticity-streamfunction method to describe the Eulerian gas flow dynamics, which is coupled to a Lagrangian particle dynamics model (Grifoll and Rosell-Llompart, 2012). The body force for the gas flow field is the reactive drag force on gas due to droplet motion. A final steady state system configuration is obtained iteratively through a series of coupled time-averaged pseudo-steady state solutions in both frameworks. With a limited number of realizations of the particle dynamics, it is necessary to use a filtering scheme that smoothly distributes the force per unit volume created by the relative movement between the 'point droplets' and the gas (Apte *et al*, 2008).

Results

We have applied this methodology to the well characterized experimental system of Tang and Gomez (1994). Figure 1 shows two snapshots of the simulated spray, one assuming still ambient gas and the other of complete gas-spray simulation under the influence of induced gas motion, including gas streamlines. The droplets produce a prominent flux about spray axis, ensued from an axial acceleration. A similar flow pattern has been reported in simulations of wind induced by corona discharges (Zhao and Adamiak, 2005). In addition, the induced gas flow produces a reduction in the plume width, which is also reflected in the radial distribution of number density shown in Figure 2. This effect is due to a reduction of the (Lagrangian) time available to the cloud for expanding under the action of electrostatic repulsion forces between the droplets. Figure 2 also shows that inclusion of induced air flow in the simulations leads to more accurate agreement with the experimental number density profiles.

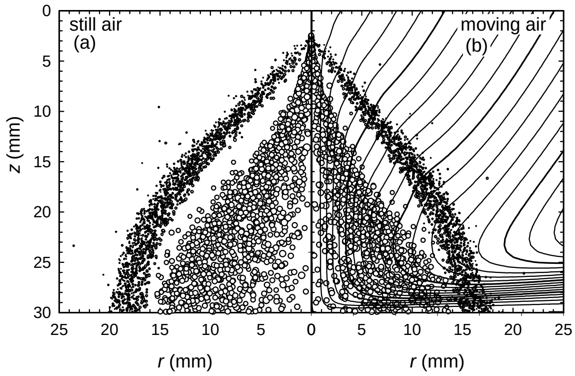

Figure 1. Snapshots of simulated spray considering still ambient gas, and induced gas flow

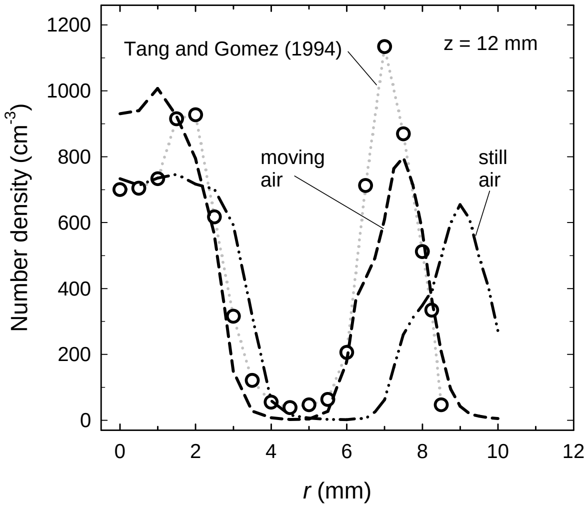

Figure 2. Radial distribution of droplet number density in comparison with experimental data

Acknowledgements

Ministerio de Educación y Ciencia (Spain), projects CTQ2008-05758/PPQ and DPI2012-35687. Generalitat de Catalunya, ref. 2009SGR-01529. A.K.A. acknowledges a Universitat Rovira i Virgili scholarship.

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