Effect of droplet size in EHDA simple-jet mode without/with whipping break-up on evaporation

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Liquid atomization is used in a number of industrial applications such as spray drying, drug delivery, spray pyrolysis, spray freezing, pesticide dispersion, fire suppression and desalination. For these applications droplet size and time of evaporation of atomized droplets is very important. For this reason electrohydrodynamic atomization (EHDA) or simply electrospraying has been used as a versatile tool in the production of well dispersed droplets with defined size (Yurteri et al. 2010). With electrospraying one is able to control the diameter of the generated droplets. For applications that require a relatively high flow rate, electrospraying in the simple-jet mode is adopted (Agostinho et al. 2012).

The objective of our study is to characterize droplet size and size distributions in the simple-jet mode for a certain flow rate and nozzle inner diameter as a function of applied voltage. We also investigated the effect of electrosprayed droplets size on evaporation ratio. In order to investigate how droplet sizes influence the evaporation ratio modelling and simulation was done using MATLAB.

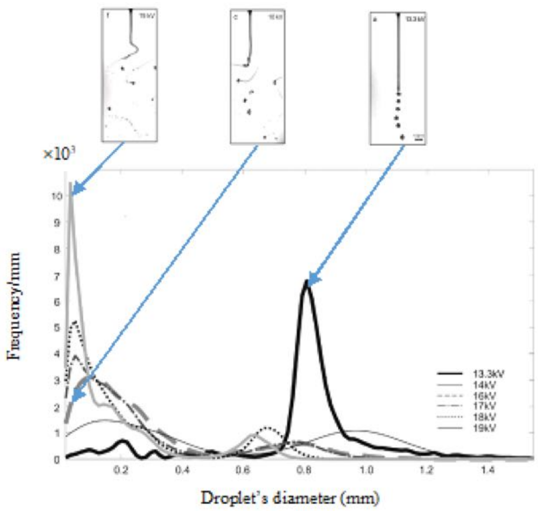

Figure 1. Relation between counted droplets of a certain diameter (interval) for different applied electrical potentials.

The evaporation chamber was modelled based on input parameters for air (mass flow rate, temperature and relative humidity) and water (mass flow rate and temperature).

Figure 1 shows that at 19 kV with a flow rate of 500 ml/hr per nozzle we are in the whipping break-up (very high percentage of droplets of less than 0.25 mm). Table 1 shows the simulation results for evaporation ratio for droplet sizes under the varicose break-up and whipping break-up. For the same initial water and air conditions the evaporation ratio in the whipping break-up is higher than in the varicose break-up. The evaporation ratio (mass evaporated over original mass) was computed only after 1 second because our model shows that much of the evaporation takes place during this time and thereafter almost no significant evaporation takes place anymore. This is in agreement with a study by Holterman (2003).

Table 1. Evaporation ratio for droplets with different initial diameter after 1 second using a nozzle with ID=0.25 mm and a flow rate of 500 ml/hr.

Droplet Size (mm)	Droplet Temp. (°C)	Initial air temp. (°C)	Initial Rel. Humidity (%)	Evap. Ratio (%)
Simple-Jet Mode (Varicose Break-up)				
0.5	80	40	30	35
Simple-Jet Mode (Whipping Break-up)				
0.25	80	40	30	77

The evaporation model created can be used to set input parameters that can be more appropriate for any evaporation process.

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