ABSTRACT

Electrohydrodynamic atomization, or Electrospraying, is a process of implementing electric stresses into a liquid breakup process by the application of a strong electric field (kV cm⁻¹). For a certain spray geometric configuration and a specified liquid, there are different modes of electrospraying depending on the electric field strength and/or liquid flowrate. The cone-jet mode is the most explored one due to its capability of producing highly charged monodisperse droplets in the nano-micrometer size range. This mode is, however, not recommended for systems that depend on electrospray at high throughput. Instead, the simple-jet mode, which operates at much higher flowrates than the cone-jet mode, is recommended for such applications. This mode can also produce monodispersed droplets, but larger than in the former mode for the same liquid properties. This mode is not as much explored as the cone-jet mode. This work was carried out in order to understand the simple-jet mode of electrospray further, so as to design appropriate systems that depend on this mode. In this work, a physical model for determining the droplet trajectories in the simple-jet mode was designed and implemented. The model was designed to solve the force balance equation, in two dimension (to ensure minimum computational time as opposed to a 3D environment) for each droplet breaking up from the jet. Deformation of the droplets was disclosed to be the major cause of the droplets’ initial displacement from the Y-axis. However, a model in a 3D environment is recommended to confirm the findings in this model. After validating the model, by comparing the theoretical and experimental droplets’ trajectories, qualitatively and quantitatively, different components of force acting on the droplets were analyzed. Out of this analysis, an air flow was recommended and investigated to manipulate the droplets’ trajectories. In order to investigate the effect of wind on the droplets’ trajectories in the model, the packing factor for the droplets was analyzed. An air flow was then introduced to the spray at a certain point below the breakup point where the packing factor was low. Similar spray deflection was observed in the model and in the experiment. This was after making an assumption of a uniform velocity field for wind in the model. This model can be used to provide design pre-parameters for those systems that depend on atomization methods at high throughput. It also introduces the possibility of calculating the droplets trajectories with the introduction of extra forces.