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Calculating minimum droplet diameter in dripping, spindle, and cone-jet modes based on experimental data in the electrospray process

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Highlights

- Decreasing percentage of droplet diameter is introduced to state the fluctuation of generated droplet diameters.
- Estimated formulas are presented based on experimental data.
- Time evolution of EHD modes detected during experiments were physically stated.
- Influence of effective parameters on droplet diameter and EHD modes are stated.

Abstract

The paper is an experimental investigation of the effect of process parameters like applied voltage, volume flow rate and distance between two electrodes through dimensionless numbers in the electrospray process, droplet diameter in particular. In addition, this study attempts to present new estimated formulas based on experimental data to ease primary evaluations of droplet diameter before any performing electrospray applications in order to reduce time and cost spending. For this purpose, a high-speed camera was used to have clear evidence of the influence of the parameters on the diameter of liquid droplets generated from acetic acid and their electrohydrodynamic (EHD) modes. In this study, the time evolution of EHD modes detected during experiments and the reasons for EHD mode geometric shapes were physically stated. The results show that decreasing the distance between two electrodes producing an electric field causes a reduction in the voltage to meet desired droplet diameter (needed minimum droplet diameter) and a switch of EHD modes occurs in lower voltages. This paper also demonstrates that the percentage of decreasing droplet diameter during the electrospray process has the extremum which can change based on changing effective parameters. Furthermore, a quick estimation for calculating minimum droplet diameter in dripping, spindle, and cone-jet modes based on experimental data is presented because it was observed the decreasing percentage of droplet diameters in each EHD mode is approximately constant unexpectedly whereas all effective parameters of the electrospray process in this research tested. Finally, another equation was also driven to calculate the decreasing percentage of droplet diameter based on dimensionless numbers, Weber and Electric Capillary numbers, using experimental data to acquire appropriate means for the primary forecast of the trend of droplet diameter production being useful for various of electrospray processes such as drug delivery, powder production, encapsulation, thin films, and electrospinning.