Electrospray characteristics of aqueous KCl solutions with various electrical conductivities

S. Faraji *, B. Sadri, B. Vajdi Hokmabad, E. Esmaeilzadeh, N. Jadidoleslam
Heat and Fluid flow research labratory, University of Tabriz, Iran
Sahandfaraji@yahoo.com and b.sadri.k@gmail.com and babak.vajdi@gmail.com and esmzadeh@tabrizu.ac.ir and info@navid.org

Abstract

In the present experimental study, the effects of electrical conductivity on electrospraying procedure are investigated. A metallic nozzle with 0.6 mm ID as high voltage electrode and a stainless steel ring as a ground electrode were employed in this work. Experiments were carried out in still room temperature. Four different aqueous KCl solutions were sprayed in various high voltages and flow rates.
For better manipulation of the disruption of a liquid into a spray of charged droplets, when subjected to an intense electric field, it is needed to study the electrospraying procedure exactly. The aim will be available when there is enough information about effects of surrounding medium and physical properties on electrospraying phenomenon. For accurate investigation, the path of sprayed liquid can be divided into 3 areas: Before liquid ejection from nozzle, at the tip of nozzle and after emission from tip of nozzle. In the literature, quality of liquid emission and types of droplet detachment from disrupted jet or cone/menisci, formed at the emitter tip, by varying physical properties such as constant dielectric, viscosity and surface tension were investigated. Present work investigates the spraying modes of water and aqueous KCl solutions with the aid of recognizing conductivity effects on electrospray phenomenon in air medium. The cone length of each case is reported and finally the behaviors of produced droplets discharging from these well-known cone shape modes after detachment are studied.
Results revealed that conductivity of dispersed solution acts a main role on forming and elongation of the cones in electrospraying procedure. The size and velocity of emanated droplets are also investigated in order to present a deep insight to the electrospraying phenomenon.

Results also demonstrate that:

- Modes of spraying change for different dispersed solutions and the effect of voltage and flow rate on the modes of spraying are presented.

- The produced cone on the nozzle elongates with conductivity increasing due to more charge on the cone surface and subsequently more EHD body force exerted on it.

- The onset voltage for appearing a cone shape on the nozzle decreases with conductivity due to the fact that the conductivity augmentation leads to more free charges on the liquid surface and results in forming of cone shape in lower applied voltage.

- Droplets bigger sizes and increasing of external applied electric field strength leads to discharging velocity diminishing with conductivity rising.

- The size of droplets produced in cone appearing modes(e.g. cone jet mode, unstable cone jet mode, ...) decreases when conductivity of dispersed solutions increase due to more charge on the emanated liquid and consequently more EHD force acting on it. It is noteworthy that the rate of augmentation of droplet sizes in this range of flow rate increases with conductivity rising.

* Corresponding author: sahandfaraji@yahoo.com