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Study on the characteristics of long-distance negative corona ionic wind by needle to mesh electrodes

Huan Chen[1], Shuai Yang[1], Yong Yang[1], Chuan Li[1]
[1] State Key Laboratory of Advanced Electromagnetic Engineering and Technology, Huazhong University of Science and Technology
e-mail (speaker): 3106907727@qq.com

When a high voltage is applied to two asymmetric electrode structures to generate a corona discharge, the ions generated by air ionization near the electrode with a smaller curvature radius move and collide with air molecules under the action of an electric field and transfer momentum to cause air flow, which is called ionic wind. Ionic wind is widely used in cooling [1], dust removal [2], drying [3] and other fields due to its advantages of no rotating parts, no noise, and low energy consumption. Recently, many research groups have studied the initiation and temporal process of ionic wind [4], the cooling and gas transmission performance of ionic wind [5] and so on. However, their research mainly focused on various characteristics of the short-distance ionic wind, and the discharge distance rarely exceeds 5 cm. The ionic wind under the long distance is more conducive to the application of large-scale electrostatic dust removal and cooling. Therefore, it is necessary to study the long-distance ionic wind.

This article studies the ionic wind with a spacing of 10 cm between the needle and the mesh. A high voltage of -10 kV is applied to the needle electrode, and the mesh electrode is grounded. The ionic wind traced by the droplet is photographed with a high-speed camera, and the flow field of the ionic wind is processed by particle image velocimetry (PIV) technology. Figure 1 shows the initial evolution process of the -10 kV ionic wind. The brighter area in the image corresponds to a higher concentration of tracer particles, and the black area indicates a lower concentration or absence of tracer particles. There is a long and narrow dark area directly below the needle tip, indicating that the ionic wind is generated at the needle tip. The ionic wind moves from the needle electrode to the mesh electrode, and the head of the ionic wind is "U-shaped". Figure 2 shows the velocity flow field at different times during the initial evolution of -10 kV ionic wind processed by PIV technology. PIV technology can measure the velocity flow field and other velocity information of ionic wind without disturbing the flow field. At the time of 200 ms, 400 ms and 600 ms, the maximum wind velocity appears at 0.5 cm $\leq$ y $\leq$ 1.5 cm, 1 cm $\leq$ y $\leq$ 2cm and 4 cm $\leq$ y $\leq$ 5 cm. With the evolution of the ionic wind, the area where the maximum velocity appears gradually approaches the mesh electrode. At the time of 200 ms, 400 ms and 600 ms, the range of jet with ionic wind velocity exceeding 0.1 m/s is -0.5 cm $\leq$ x $\leq$ 0.5 cm, 1 cm $\leq$ x $\leq$ 1cm and -1.5 cm $\leq$ x $\leq$ 1.5 cm. The maximum velocity of ionic wind and the range of jet flow increase with time.

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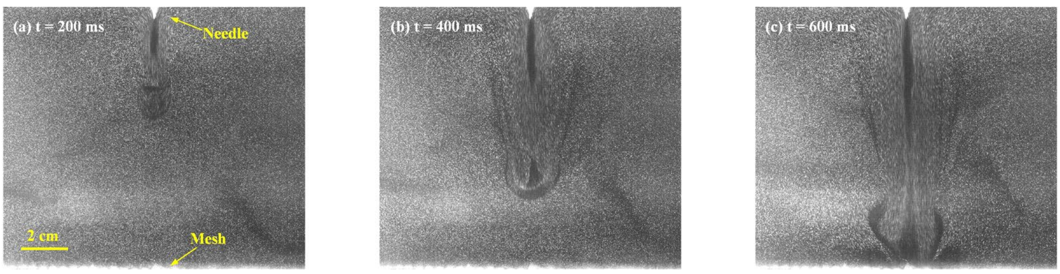

Figure 1. -10 kV corona ionic wind initial evolution process at (a) t = 200 ms, (b) t = 400 ms and (c) t = 600 ms.

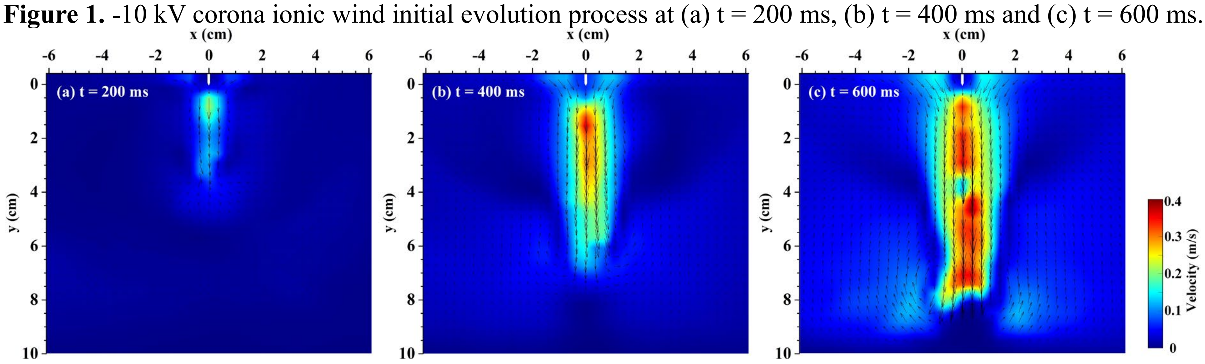

Figure 2. -10 kV corona ionic wind velocity flow field at (a) t = 200 ms, (b) t = 400 ms and (c) t = 600 ms.