A cooling method based on ionic wind generation

Muhammad Mubashir Iqbal[1, *], Abid Hussain[1], Muhammad Umar Munir[1], Ahmed Usman Yasir[1], Noman Ali[1]
[1] Department of Mechanical Engineering Faculty of Mechanical & Aeronautical Engineering University of Engineering and Technology Taxila, Punjab Pakistan
*muhammadmubashar928@gmail.com

ABSTRACT

Improvement of cooling is a significant problem in the thermal management of electronic devices. Devices can be more difficult to cool as their dimensions shrink, resulting in a confined dissipation space. Despite this, there are few effective solutions. Experiments were conducted to examine the electrode gap, inception voltage, and discharge current of an ionic wind generator based on the operation voltage. Various electrode gaps and voltages were used to investigate the ionic wind velocity within the device. A variety of operation parameters were considered when analyzing the temperature drop achieved by the ionic wind. A new kind of cooling for mobile electronics is possible through ionic wind generation (IWG). Although ionic wind generation cooling is currently only applied to small areas, it is still limited by a few unknown parameters: maximum wind velocity, minimum operational voltage, and degradation of corona-displacing electrodes. The objective of this study is to investigate these parameters based on an ionic wind generation system consisting of semi-cylindrical contour electrodes as well as wire electrodes. Our studies included various electrode diameters, electrical configurations, and operating conditions for ionic wind generation systems. To accelerate the application of ionic wind generation cooling systems, experimental studies can provide a greater understanding of how they work.

Keywords: Discharge current; Electrode; Ion wind Generation

1. INTRODUCTION:

Ionic wind generation IWG has become a significant part of electrohydrodynamic (EHD) which was introduced almost 30 decades ago. In the present time, IWG has become vital in the thermal management of microelectronics as well as is used as a cooling method in a conventional rotary fan. The devices based on IWG do not have moving parts due to this feature it has many positive edges like silent working, flexible form factor, and declined thermal solution volume requirements [1-3]. The heat generation is increasing day by day that's the demand for the smart flexible device. Many studies have been done on IWG-based cooling methods and also have given a specimen that can change the mechanical fan in a desktop [4-5].

We have conducted an experiment on IWG for revealing the wind velocity, operation voltage, and degradation of corona discharging electrodes based on the IWG specimen assuming different parameters like geometric design, electric configuration, and operation condition. Geometric design has been considered as the diameter of wire electrodes[6-7].

2. EXPERIMENTAL SETUP

By using a typical electrode configuration of wire and semi-cylinder counter-shaped we made a sample of IWG which was suggested by Schlitd et al [8]. This sample comprises platinum (pt.) or tungsten (w) wire (diameter (d)¼ 25,50 or 75mm) and another electrode of brass(diameter(D)¼ 3or 4mm and thickness 1/4 mm) [9].

The flow of direction of IWG is perpendicular to a consistent and reproducible device. However, the radial flow of semi-circular will be in a single electrode, axis components of radial flow will cut to each other and will not affect the direction of the main flow. during the dissipation process of radial flow, irregular wakes will occur, and they have almost zero effects on the main flow direction [10].

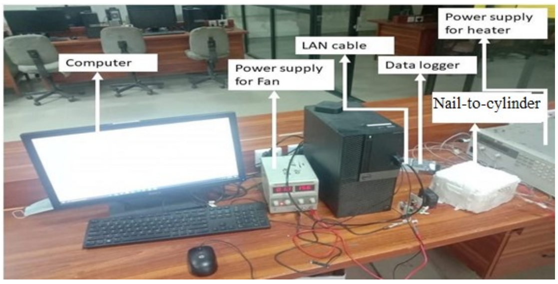
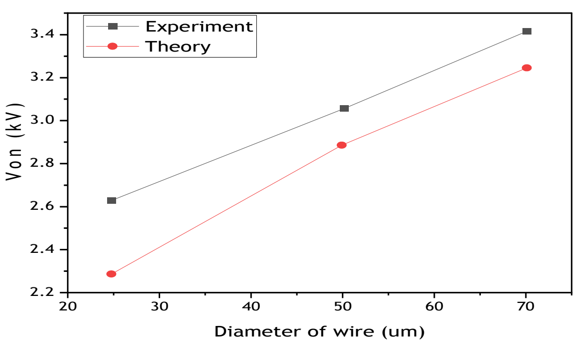


Figure 1: Actual view of an experimental setup

3. Results and Discussion

3.1 Experimental validation

Figure 2 reveals the difference between experimental instances averages nail to cylinder temperatures. The results of the study illustrate good agreement and demonstration that a recent



experimental paradigm can be applied.

Figure 2: Experimental Validation for Theory

3.2 Effect of geometric parameters on IWG performance

3.2.1 Effect of the diameter of the wire on operation voltage and power efficiency

We notice that reducing the diameter of the wire gives a smaller onset voltage to initiate IWG (von) and operation voltages. The diameter of the wire with respect to the experimental results Von agrees with the expression fig 3. The negligible difference of von between experimental conclusions and the expression attributed may be due to the difference in geometry between the cylinder and semi-cylinder shape. The result of wire and semicylinder lies in a small electric field while the results of wire and cylinder lie in a higher electric field [11-12].

By changing the diameter of the wire power efficiency will be changed. Thus, using wires of smaller diameter is favorable in the designing of IWG.

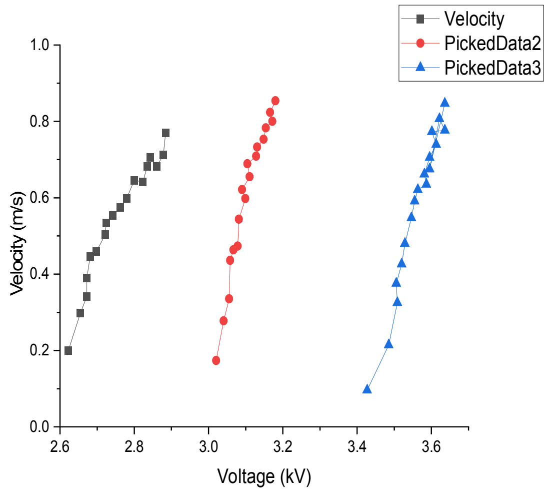


Figure 3: Velocity is measured with respect to voltage

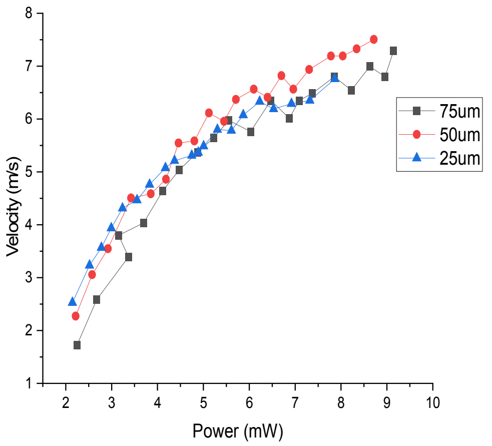


Figure 4: Velocity is measured with respect to electrical power

3.2.2 Effect of the diameter of the ground electrode on operation voltage and power efficiency

By changing the diameter of the ground electrode, the power efficiency almost remains the same. When the diameter of the ground electrode is small, then the distance gap between two electrodes will be smaller as a result a strong electric field will be induced due to this smaller diameter. It is clearly seen that reducing the distance gap is very helpful in the design of IWG. Nevertheless, for producing IWG the proportion of gap distance per wire diameter should be more the critical value. For instance, if the gap distance is 1.25mm then the ratio will be more than 25:1, and reducing the gap distance, the requirements cross 100:1. So, we must be looked the ratio before applying the diameter of a smaller electrode to the IWG design [13-15].

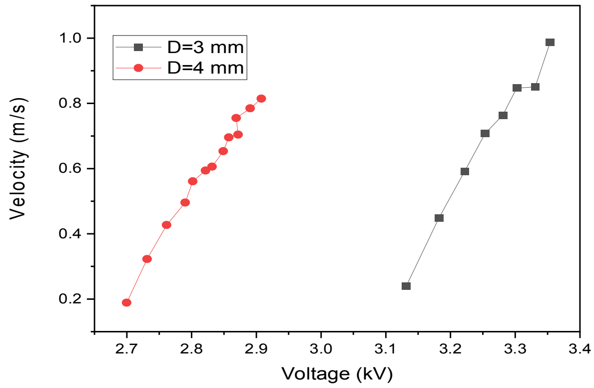


Figure 5: Velocity is measured with respect to electrical power

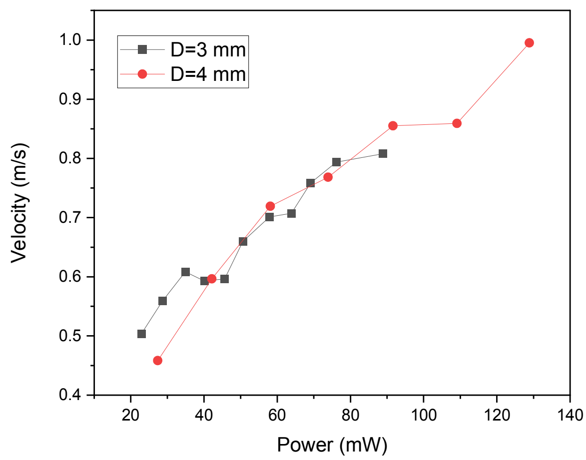


Figure 6: Velocity is measured with respect to voltage

3.3 Effect of electric configurations on IWG performance

3.3.1 Effect of DC positive and DC negative on wind velocity with respect to voltage and electrical power

When a voltage is applied between electrodes DC negative gives more wind velocity as compared to DC positive. The result may be by applying the same voltage, DC negative produces more current as compared to DC positive due to emitting more electrons from a wire. So, DC negative contributed most to the production of IWG.DC positive has more wind velocity than DC negative in terms of electric power. According to velocity measurements voltage, current, and DC negative require less voltage to produce the same wind velocity as DC positive. Thus, DC positive is more helpful for electric power as compared to DC negative. According to the operation of the negative corona, discharge electrons should attach to oxygen, water vapor, and carbon dioxide which are electronegativity gases. Negative corona discharge uses a small portion of air than positive corona discharge [16-19].

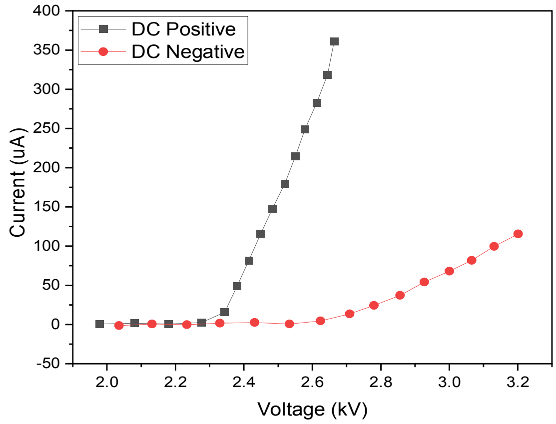


Figure7: Velocity is plotted with respect to applied voltage between the wire (Pt, d ¼ 25 um) and ground electrode (D ¼ 4 mm).

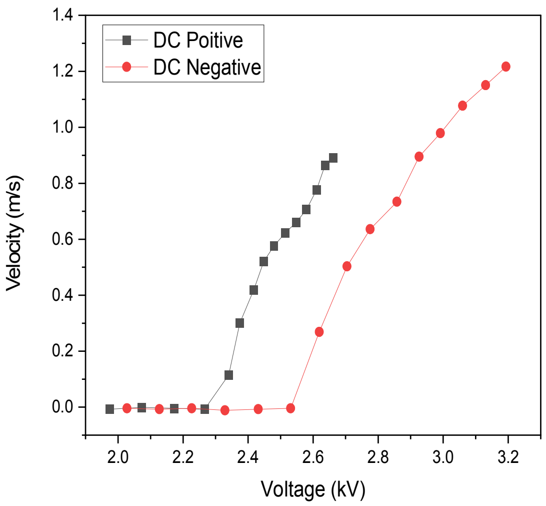


Figure 8: Velocity is plotted with respect to applied voltage between the wire (Pt, d ¼ 25 um) and ground electrode (D ¼ 4 mm).

4. CONCLUSION

This paper reveals how experimental probing by considering different parameters like geometric design, electric configurations, and operational conditions affect the performance of the IWG prototype which consist of a wire electrode and a semi-cylindrical countered-shaped electrode. The experimental conclusions are

- For the electrodes that have a smaller diameter, the power efficiency of such electrodes remains the same, but they give to smaller operational voltage.
- DC negative gives more velocity as compared to DC positive by applying the same voltage however the power efficiency of DC positive is much better than DC negative. the frequency-dependent velocity like peak frequency and critical frequency can be achieved through AC configuration at this frequency wind velocity show fluctuation which means that wind velocity gives maximum value and disappear respectively. The operational voltage of the AC configuration is the lowest followed by DC negative and DC positive.
- When increasing operational voltage and decreasing power efficiency is observed then degradation of wire depends upon many operational conditions.

5. REFERENCES

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