

## Comparison the Formation of Spark Corona Discharge between Tap and distilled Waters at Liquid Electrode System

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### Abstract:

In this paper, we studied the spark corona discharge in tap and distilled waters. The results show the shape of cone that generated on the tip of capillary tube is different with conductivity of liquids. The blue glow appears at the end of capillary tube and the drop extends into a cone. In addition, the conductivity is affected on the relationship between the appearance of the blue glow discharge with the applied voltage. The size of the cone decreases with an increase in applied voltage. The cone diameter at the base of capillary tube oscillates with period approximately 1 Sec. this oscillates in the cone diameters is due to the change distance between the liquid electrode and the surface of liquid. The intensity of spark corona discharge that formed in tap water higher than that formed in distilled water. In addition, when the applied voltage is 5 KV on distilled water, the drope extends into two cones while in tap water the drop extends into one cone. These contrast between two water types which under test (i.e. tap and distilled waters) is due to the difference in conductivity of water.

**Keywords:** Corona discharge, liquid discharge, Tap water, Distilled water.

### Introduction:

Plasma is ionized gases which consists of positive and negative ions, and electrons as well as neutral species. The plasma state is regarded the fourth state of matter. In general, plasmas are classified into two kinds: thermal equilibrium plasma and non-thermal equilibrium plasma. Thermal equilibrium implies that the temperatures of all species, including electrons, ions and neutral species are the same. On the other hand, non-thermal equilibrium means that the temperatures of the different plasma species are not the same. More precisely, the electrons are characterized by much higher than temperatures than the heavy particles (ions, atoms, molecules) [1]. Non-thermal plasma can drive high-

temperature chemistry at low ambient temperatures using input energy levels that are lower than the energy required for driving an equilibrium reaction. The wide variety of chemical non-equilibrium conditions are possible in which parameters can easily be modified by external control, such as chemical input, pressure, electromagnetic field structure, discharge configuration, and temporal behavior. Due to this multi-dimensional parameter space of the plasma conditions, plasma are employed in a number of applications, such as plasma spectra-chemistry, cutting, spraying, welding, etching or deposition of thin layers and catalysis [1-3]. Recently, electrical discharge in liquids have received particular

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attention because the nonthermal plasma generated by these discharges initiate various chemical and physical processes that can be potentially utilized in different environmental, biological, or medical application. Depending on the type of the discharge and the input energy, these processes include high electric field, ultraviolet radiation, and overpressure shock wave are of particular importance[4]. Understanding the properties of the water is essential for a wide range of physical and biological processes, and is a key point in many areas of technological development. A number of the thermodynamics and transport properties of liquid water exhibit unusual behavior, especially at low temperature [5]. In the supercooled regime below the melting point, the behavior of water, seems to indicate that there is a singular temperature at which various thermodynamic response functions and transport properties diverge. Scientists have long sought a coherent explanation for this behavior [5-7]. A second and related puzzle currently being debated concerns how one determines the virification temperature of supercooled water [5,8].

### Materials and Methods:

Figure (1) shows a schematic view of the apparatus used in this study. The apparatus consisted of a glass vessel 1 of 250cm<sup>3</sup> in volume, which is filled with 150 cm<sup>3</sup> of a liquid to be treated. The liquids which treated in this work are tap and distilled waters. The glass vessel had a rubber head 2 with a fixed electrode 3 and glass tube 4 of 2 mm in inner diameter: at the end of glass tube, glass capillary tube 6 of 0.12 mm in inner diameter was fastened. Above the head, reserve feed container 5 of 150 cm<sup>3</sup> in volume for an electrode liquid was mounted on capillary tube 6. A corona discharge was excited in air between the surface of liquid and liquid electrode. From a d.c. power supply 8 was applied to the liquid in the vessel container through ballast resistor 7 with a resistance of 2 MΩ. To run the experiment, liquids (tap water and distilled water) from a container 5 were sucked into tube 4 and capillary tube 6 with a rubber bulb. The length of capillary 6 was 4.5 cm and that of tube 4 was 2 cm. the distance between the capillary end and the liquid surface was maintained at about 1 cm.

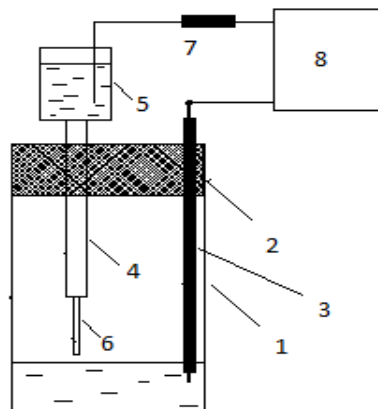


Fig.(1): Schematic of the experimental set up: 1) Glass reaction vessel,2) The glass vessel had a rubber head, 3) fixed electrode, 4) Glass tube, 5) container for the electrode liquid, 6) glass capillary tube, 7) ballast resistor, and 8) d.c. power supply.

### Results and Discussions:

The processes occurring at the tip of the capillary are illustrated in figures (2) and (3) which present photographs of the electrode at various voltages for different water types. It is clear from these figures, in the absence of the voltage, a drop is formed at the tip, which increases to large dimensions and falls. When the voltage is applied, the drop diameter increases, and the drop extends along the electrode axis. When the voltage 2 KV is applied, a blue glow appears at the end of the capillary tube and the drop extends into a cone. The size of the cone decreases with the increase of the applied voltage. As well as, the cone diameter at the base of capillary tube oscillates with period approximately 1 Sec. this oscillate in the cone diameters is due to the change distance between the liquid electrode and the surface of liquid. This behavior was shown in

both waters. Piskarev et.al. [9] showed the same results. Electrical conductivity is a measure of the ability of a solution to carry a current. Current flow in liquids differs from that in metal conductors in that electrons cannot flow freely, but must be carried by ions. Ions are formed when a solid such as salt is dissolved in a liquid to form electrical components having opposite electrical charges. Generally, since the tap water and distilled water are different in conductivity (where the measured electrical conductivity of tap and distilled waters is  $30\mu\text{hm/cm}$  and  $18\mu\text{hm/cm}$ , respectively), so there are some different results can be seen between both figures. The difference between both water types are: the tap water showed high intensity discharge between the liquid electrodes. The shape of the cone that generated at the tip of capillary tube is different too.

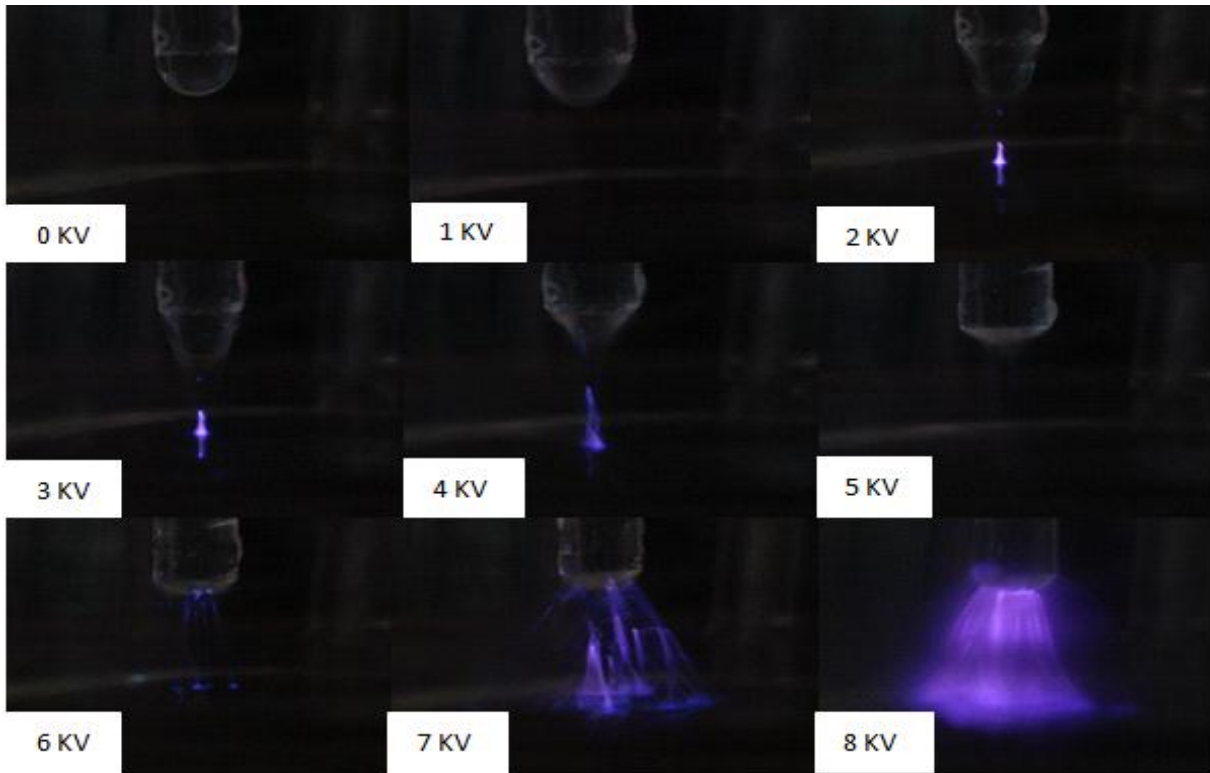


Fig.(2): Photograph of the tap water electrode without applied voltage and under different voltages.

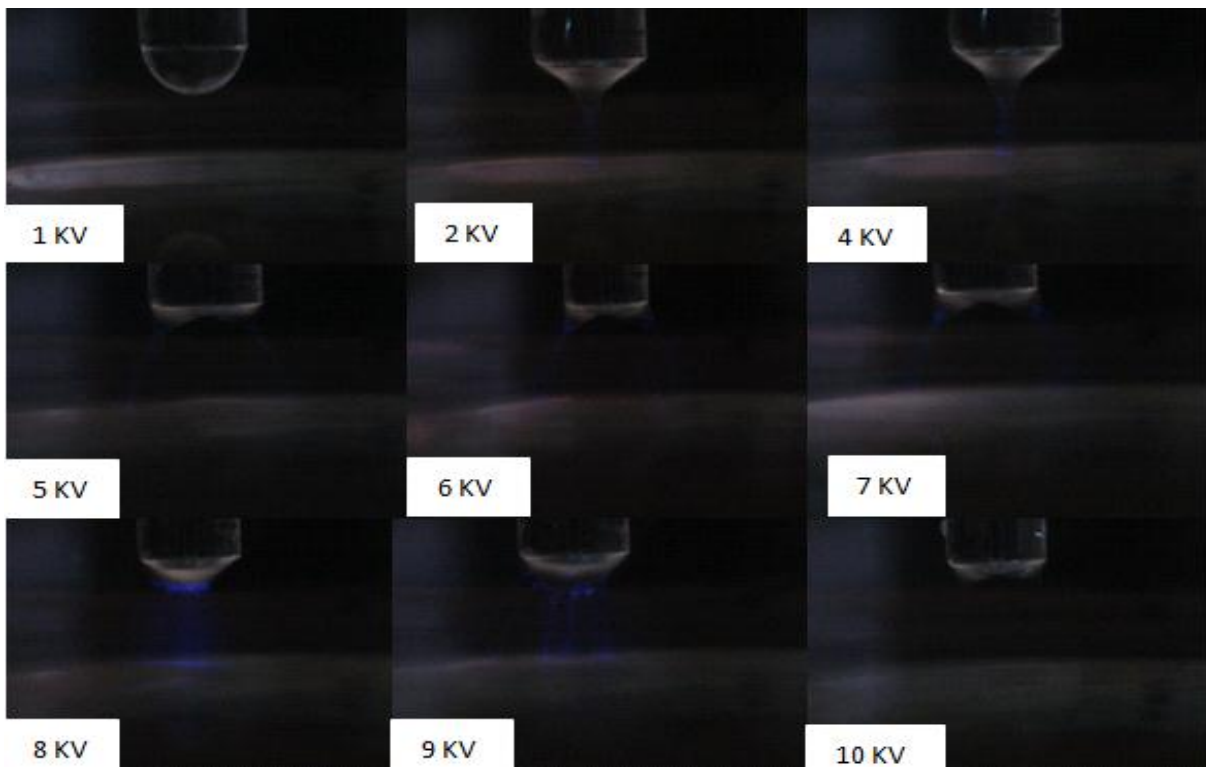


Fig.(3): Photograph of the distilled water electrode without applied voltage and under different voltages.

In this paper, we studied the spark corona discharge that is formed between two liquid electrodes in the tap and distilled waters. The results showed that the shape of cone that generated on the tip of capillary tube is different with conductivity of liquids. The blue glow appears at the end of capillary tube and the drop extends into a cone. In addition, the conductivity is affected on the relationship between the appearance of the blue glow discharge with the applied voltage. The size of the cone decreases with an increase in applied voltage. The cone diameter at the base of capillary tube oscillates with period approximately 1 Sec. this oscillate in the cone diameters is due to the change distance between the liquid electrode and the surface of liquid. The intensity of spark corona discharge that formed in tap water is higher than that formed in distilled water. In addition, when the applied voltage is 5 KV, the drop extends into two cones.

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## المقارنة بين تكوين التوهج الاهليلي النبضي لماء الحنفية والماء المقطر لمنظومة ذات الاقطاب السائلة

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### الخلاصة:

في هذا البحث تم دراسة التفريغ الاهليلي النبضي المتكون في ماء الحنفية والماء المقطر. ان النتائج هذا البحث قد اوضحت بان شكل قطرة الماء المتكونة في نهاية الانبوب الشعرية تتغير مع تغير التوصيلية السائل. و كما لوحظ ظهور توهج ازرق في نهاية الانبوب الشعري وان القطرة الماء المتكونة في نهاية الانبوب تكون على شكل مخروط. وان التوصيلية السائل لها تأثير كبير العلاقة بين ظهور التوهج الازرق و الفولتية المسلطة. و ان حجم المخروط المتكون يقل مع زيادة الفولتية المسلطة. وان قطر المخروط في نهاية الانبوب الشعري يتذبذب بزمن ي مقداره ثانية واحدة. وان هذا التذبذب ينشأ بسبب التغير المسافة بين قطب السائل و سطح السائل. ان شدة التوهج الاهليلي النبضي المتولد في ماء الحنفية يكون اكبر من شدة التوهج المتكون في الماء المقطر. بالاضافة الى ذلك عندما تكون الفولتية المسلطة 5 كيلو فولط في حالة الماء المقطر فان قطرة الماء المتكونة في نهاية الانبوب الشعري ستكون على شكل مخروطين بينما في حالة ماء الحنفية ستكون على شكل مخروط واحد. ان هذا الاختلاف بين كلا نوعين من الماء يعزى الى الاختلاف التوصيلية بين كلا نوعين من الماء.