

## MEASUREMENT PROBLEMS AND METHODS IN THE RESEARCH OF PHENOMENA IN THE CORONA DISCHARGE

**Annotation.** *The simulation of the appearance of corona discharge was considered. For this purpose, a hardware system was constructed for research of corona discharge and the phenomena arising in it.*

**Keywords:** *corona discharge, measurement methods, UV radiation, high voltage.*

### Introduction and statement of the problem

Corona is one of the phenomena connected with all energized electrical mechanisms, including high-voltage transmission lines. The localized electric field near a conductor can be reasonable concentrated to ionize air close to the conductors. So, it can result in a partial discharge of electrical energy called a corona discharge.

The condition for the appearance of this discharge reflects the physical mechanism of the reproduction of electrons in the area of the amplified field, where ionization occurs. The mechanism of electron multiplication depends on the polarity of the corona electrode. If it is a cathode, then the corona is called negative. Secondary process is emission from the cathode, also in a small region, stepwise ionization in the gas volume. If the corona electrode is an anode, then the corona is called positive. A remote large cathode, near which the field is weak, does not participate in reproduction, then secondary photoprocesses in the gas in the tip zone are responsible for the reproduction of electrons. In contrast to the smooth luminescence of the negative corona, there are filaments running away from the point in the positive corona. These threads are called streamers.

The corona discharge has been applied in various branches of science and technology. Corona can be used to generate charged surfaces, which is an effect used in electrostatic copying (photocopying). They can also be used to remove particulate matter from air streams by first charging the air, and then passing the charged stream through a comb of alternating polarity, to deposit the charged particles onto oppositely charged plates.

But sometimes corona discharge can generate audible and radio-frequency noise, particularly near electric power transmission lines. They are a source of power loss, and their action on atmospheric particulates, along with associated ozone and NO<sub>x</sub> production, can be harmful to human health where power lines run through built-up areas.

### Goals

The main purpose of this work is research the phenomena arising in the corona discharge and to determine the dependence of the intensity of UV emission on the voltage applied to the electrodes.

### The main part

We chose a reliable scheme of a local oscillator on MOSFET transistors, as a source of high voltage, for creating a corona discharge (Fig. 1). By changing the input voltage, in this generator it is possible to change the output voltage too. So, it is possible to obtain a high voltage power supply regulated within a certain range (15 - 35 kV) for our experiment.

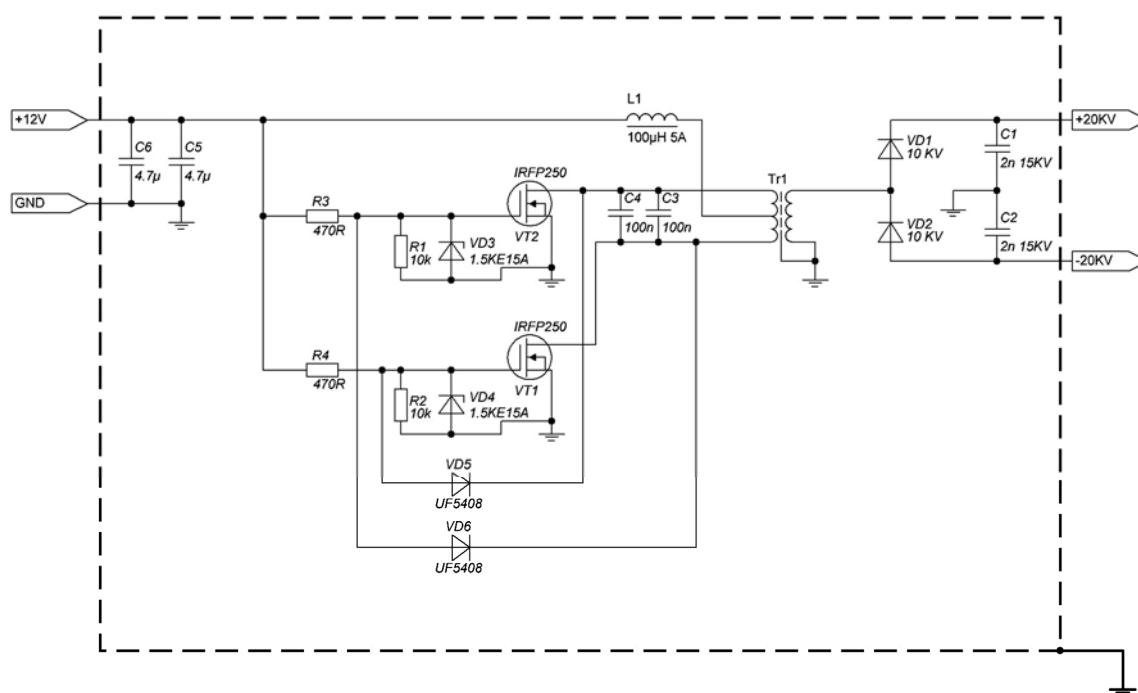


Fig. 1 – Schematic of a high-voltage power supply used to maintain the corona discharge

For measuring of voltage at the output, a high-voltage divider was assembled. In the upper arm, it has a resistor rated at 1 GΩ, and in the lower one has 100 KΩ. After that, a repeater buffer was placed on the

op-amp with the LPF. The buffer on the op-amp is needed to match the resistances.

In the course of the experiments, we decided to use a voltmeter with a coil resistance of 30 k $\Omega$  for current measurement. This voltmeter was connected in series with the positive terminal of the high-voltage power supply. This device was used as an ammeter in this mode. The discharge current was in the range 20 – 140  $\mu$ A. I–V curve

With the using of the considered measuring and providing devices, current–voltage characteristic of a corona discharge was obtained. (Fig. 2).

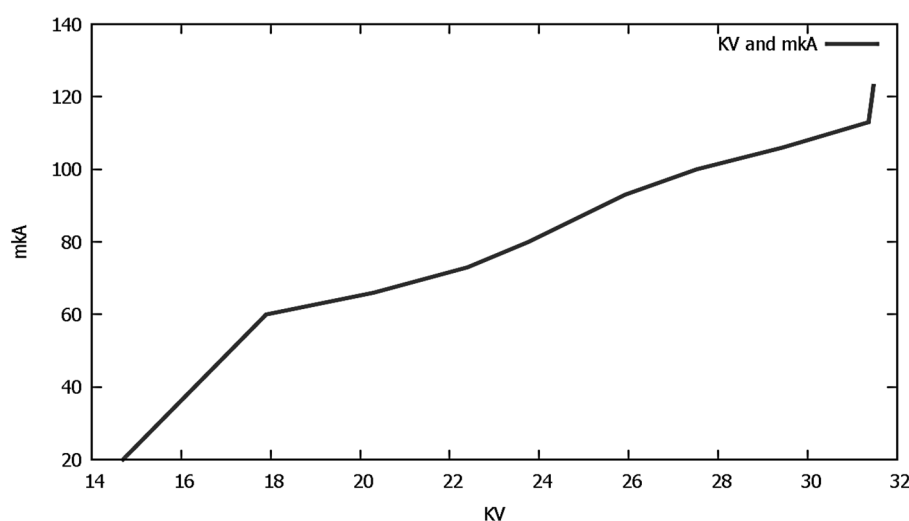


Fig. 2 – I–V curve of the corona discharge

Since the corona discharge emits ultraviolet, which is released during photoionization, and its intensity is related to the voltage applied to the electrodes, a graph was constructed to investigate this dependence.

We selected the ML8511 sensor for measuring of UV (ultraviolet radiation). This sensor is capable of producing an analog signal of 1-3 volts, depending on the intensity of UV radiation. A significant advantage of this sensor is the fact that it reacts poorly to the UV radiation of the sun. The sensor covers a range of wavelengths from 280 to 560 nm.

The analog output of the sensor produces a voltage of 1 to 3 volts, in order for the variable values to be from 0 to 2 volts, it was decided to subtract this 1 volt by means of an op-amp. For this purpose, a scheme was developed that subtracted the "extra" voltage. (Fig. 3)

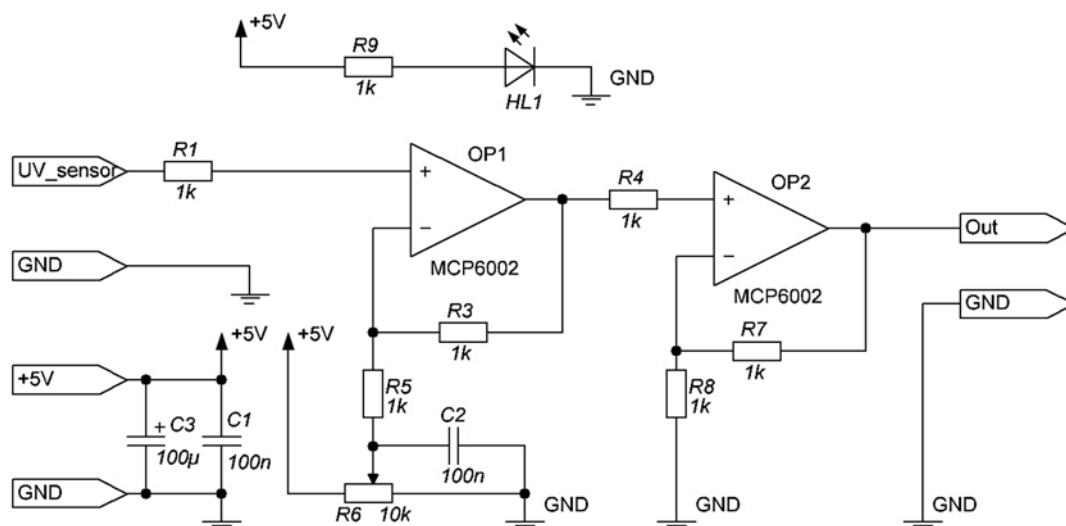


Fig. 3 – Schematic for processing a signal with a UV sensor

After assembling and debugging this scheme with the ML8511 sensor, the sensor was placed in the metal tube, which was grounded. This was necessary to minimize interference that came from the corona discharge.

After checking the efficiency of the sensor, the first measurement was made. It was the regularity of the intensity of UV radiation from the voltage that was supplied from the high voltage source to the discharger electrodes. (Fig. 4)

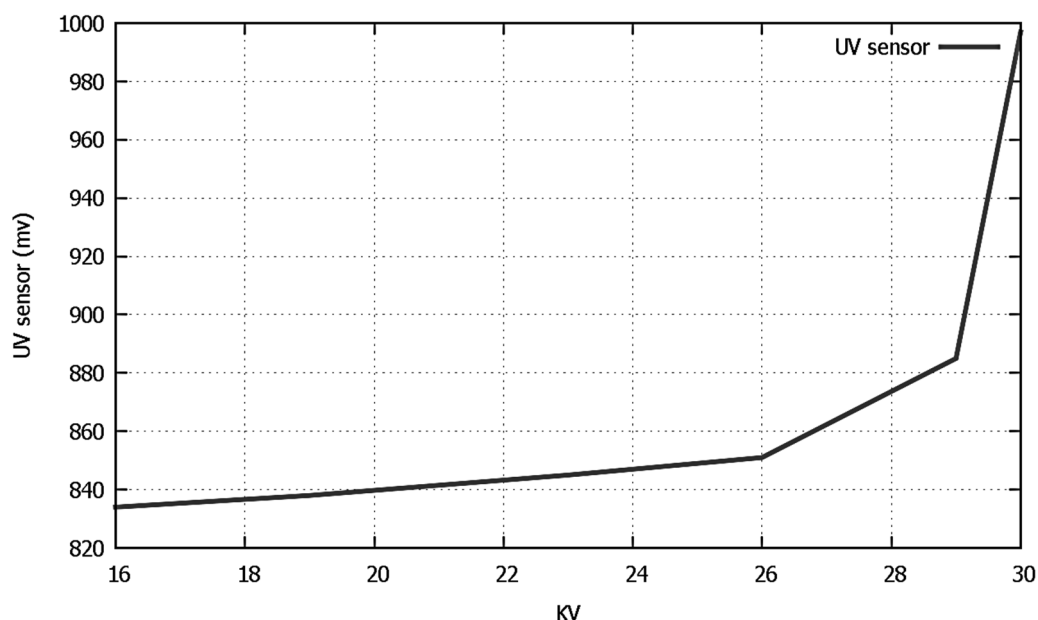


Fig. 4 – Dependence of intensity of UV radiation on voltage

After plotting the graph and making sure that the UV separation is associated with the applied voltage, it was decided to measure the intensity of the ultraviolet in the anode and cathode areas.

The sensor was installed at a distance of 30 mm from the corona discharge, and its "lens" was directed to the anode, then to the cathode, then to the midpoint between them.

Based on the received data from the sensor, as well as the measured current and voltage at the same points, three graphs were constructed. All graphs show the intensity of UV radiation in the area of the cathode, the anode and the mean between them. (Fig. 5-7)

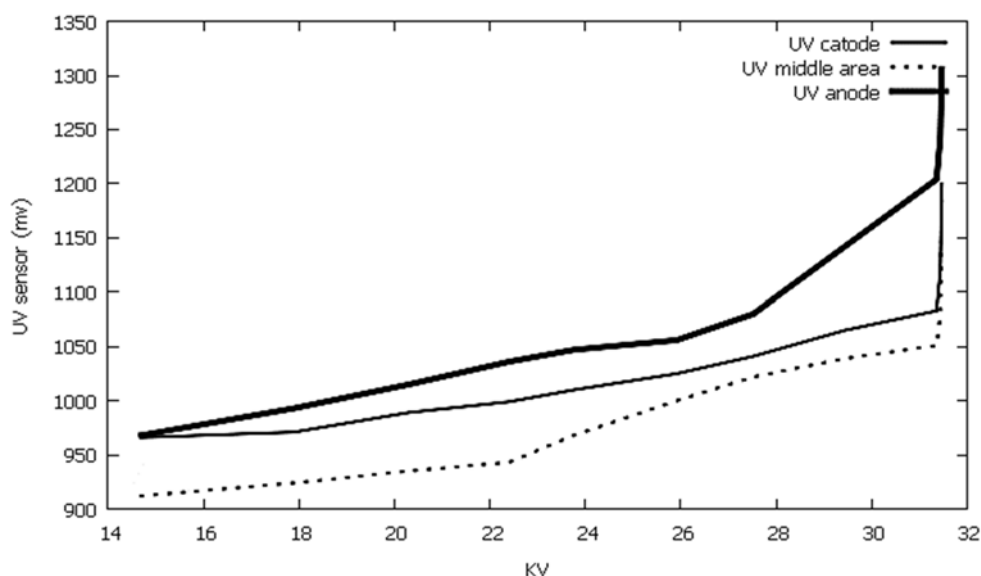


Fig. 5 – Dependence of the intensity of UV emission in the areas of the cathode, anode and middle area to the voltage of the corona discharge

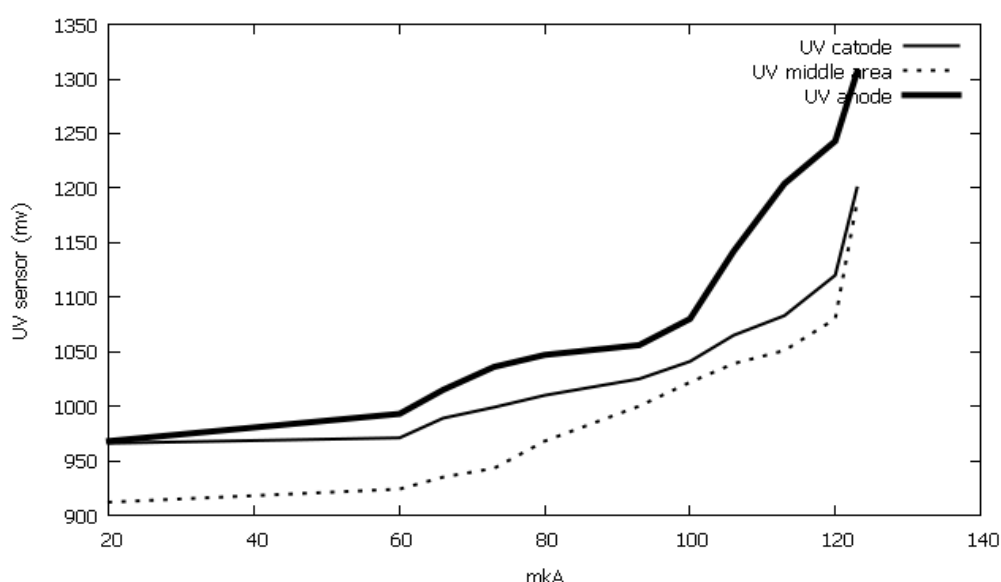


Fig. 6 – Dependence of the intensity of UV emission in the areas of the cathode, anode and middle area to the current of the corona discharge

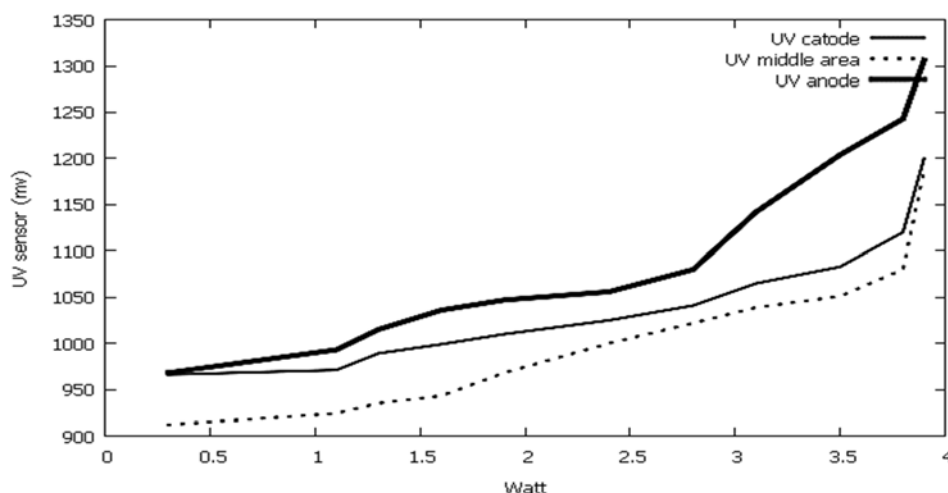


Fig. 7 – Dependence of the intensity of UV emission in the areas of the cathode, anode and middle area to the power consumed by the corona discharge

Since the anode was the corona electrode, the corona was positive, and therefore, the secondary photoprocesses in gas, in the tip zone, are involved in the reproduction of electrons. As a result of these photoprocesses, the UV emission in the anode region was greater, which agrees with the results obtained by Yu. P. Raizer.

### Conclusions

The created hardware complex allows to obtain a corona discharge, to measure the UV radiation of the corona discharge, as well as its current and voltage applied to the electrodes.

On the basis of the data obtained, a current–voltage characteristic of a corona discharge was made, the dependence of the intensity of UV emission on the voltage applied to the electrodes. UV radiation was also measured in the areas of the cathode, the anode, and the middle region between them, and plotted the dependences with the discharge current, the voltage at the electrodes, and the power consumed by the discharge. The data obtained are close to those were obtained by Yu. P. Raizer, but they require additional research, data will be collected for further research and model building based on this measurement complex.

### References:

1. Yu.P. Raizer Gas Discharge Physics/ Yu.P Raiser - Moscow: Nauka, 1992. - 434p.
2. Horovits P. The Art of Electronics / P. Horowitz, W. Hill. - Moscow: Mir, 1995. – 154p.