ELECTROMAGNETIC EMISSIONS OF AC HIGH-VOLTAGE CORONA

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ABSTRACT

This article deals with the corona discharge and electromagnetic emissions. It describes the emergence of discharge and its manifestations. It describes the measurement set, and used measuring instruments. Measurements were carried out on the tip-electrode system hemisphere. It demonstrates the effect of polarization of the receiving antenna to receive interference.

KEYWORDS

Corona discharge, electromagnetic interference, electrode system, biconical antenna, FEMM

1. INTRODUCTION

In operating the HV and VHV are often problems with their disturbing influences of electronic equipment around. Electromagnetic emissions, caused mainly by high-voltage equipment fault conditions are subject to frequent disputes between the operator and the general population.

Among the sources of electromagnetic emissions is incomplete single discharge, which is known as the corona. Raising the voltage between highly curved and relatively distant conductors (electrodes), electric field intensity reaches the critical value of the conductors, which is sufficient for the development of corona discharge, which is limited to a narrow layer around the conductors. The manifestation of the corona is weakly luminescent layer, which conductor clothes. Other associated events include: audible noise, mechanical vibrations, chemical reactions and energy loss.

2. MEASURING SET

Measuring set is shown in Fig. 1. Measurements I have performed at the electrode system tip-hemisphere. This system consists of a circular rod electrode tip ending. It is beveled at an angle of 7 ° and the end point has a radius of 0.375 mm. The second electrode consists of hemisphere with a radius of 25 mm. The model was placed on a wooden table at 1 m from the antenna at 1 m above ground level.

To receive the electric field components were used biconical antenna PMM BC-01. Antenna was located at a height of 1.5m above ground level. The antenna was connected by coaxial cable with EMI TEST SIGNAL ANALYZER PMM 8000 PLUS (9 kHz - 1.2 G Hz). In principle, it is selective mikrovoltmeter that realigns the desired frequency range and for a set period of time measured signal level at a given frequency. The source of test voltage has been without-discharge transformer Micafil with range of 0 to 150 kV, 50 Hz.

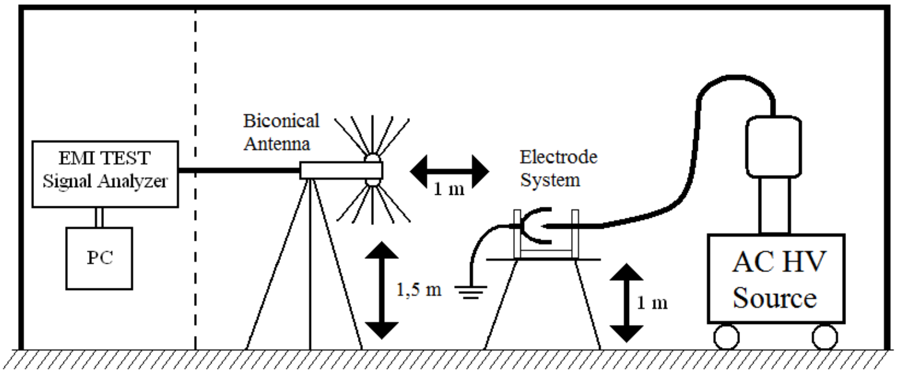

Figure 1 – Schema of measuring set

3. MEASURING PROCEDURE

After connecting all devices and the location of the antenna, I measured the electromagnetic background of the laboratory. In Fig. 2 is set analyzer.

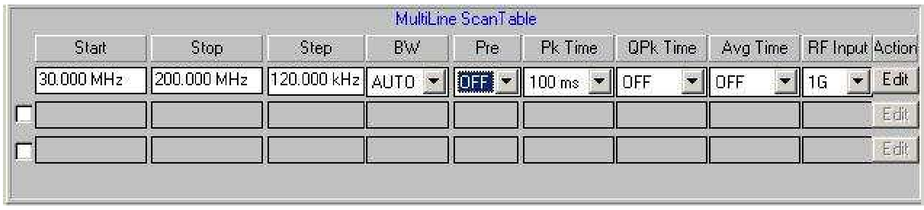

Figure 2 – Set Analyzer

I conducted interference measurements in the range from 30 MHz to 200 MHz in full range of the antenna, with step 120. The level of interference was sensed by peak detector. Scanned data are stored in the frequency domain into the PC. After measuring the electromagnetic background of the laboratory, I turned on the source of high voltage and gradually increased the voltage to the first manifestations of the corona (audible noise) at a voltage of 6.5 kV (effective value). Then again, I run the analyzer and measured electromagnetic emission from discharge. Then I increased the voltage on the next step. I repeated this process until the desired voltage 11.5 kV. I have performed measurements for both polarization antennas, horizontal and vertical.

4. MEASUREMENT RESULT

In Fig. 3 is the simulation of the electrode system and the distribution of the electric field at a voltage of 6.5 kV (effective value). The simulation is resolved in the program FEMM 4.2. Detailed view of the electric field near the tip is shown in Fig. 4.

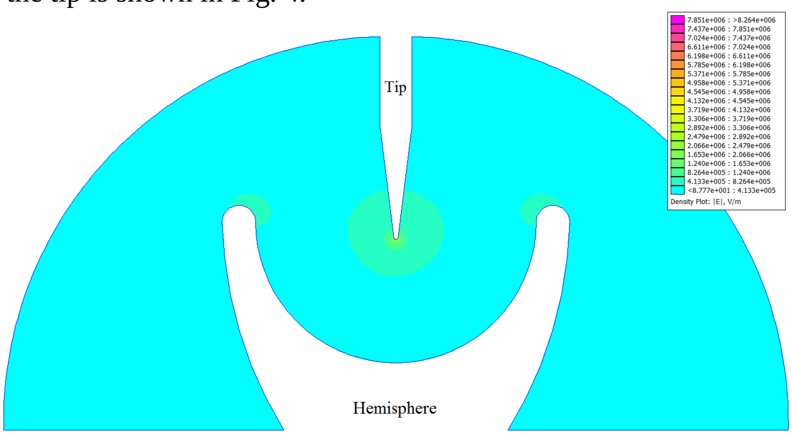

Figure 3 – Simulation of electrode system tip-hemisphere

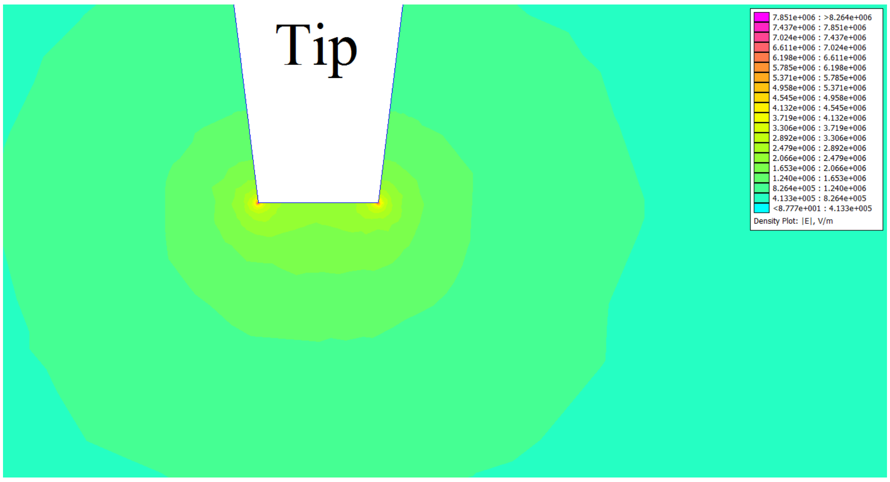

Figure 4 – Detail distribution of the electric field near the tip

The following examples show the results of the electromagnetic emission of corona discharge at inception voltage 6.5 kV and a maximum voltage 11.5 kV, as compared with electromagnetic background laboratory. All the measurements I have performed 3 times and the resulting waveform is the arithmetic mean.

4.1. Horizontal Antenna Polarization

The horizontal polarization antenna and voltage 6.5 kV, the course of electromagnetic emissions is shown in Fig. 5. The lower and middle frequencies are certain level of noise relative to the background. At higher frequencies from 150 MHz to no interference.

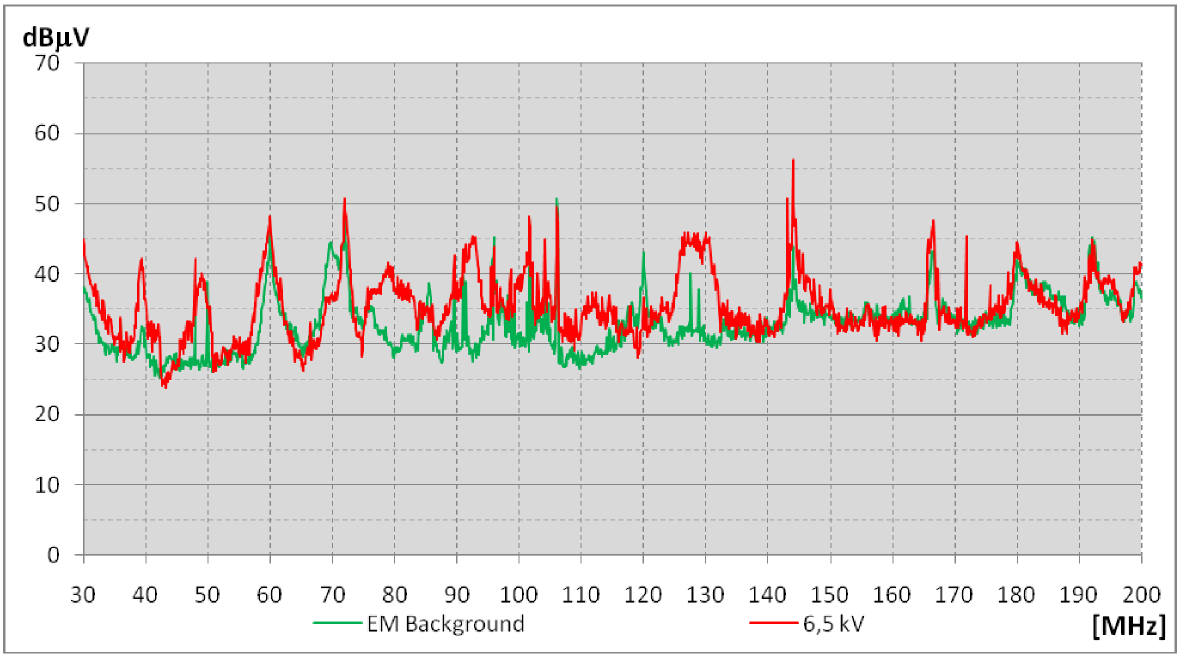

Figure 5 – Electromagnetic emissions at 6.5 kV, horizontal polarization antenna

The course of electromagnetic emissions at voltage 11.5 kV is shown in Fig. 6. The lower and middle frequencies, interference level increased in contrast to 30 dBµV versus background laboratory.

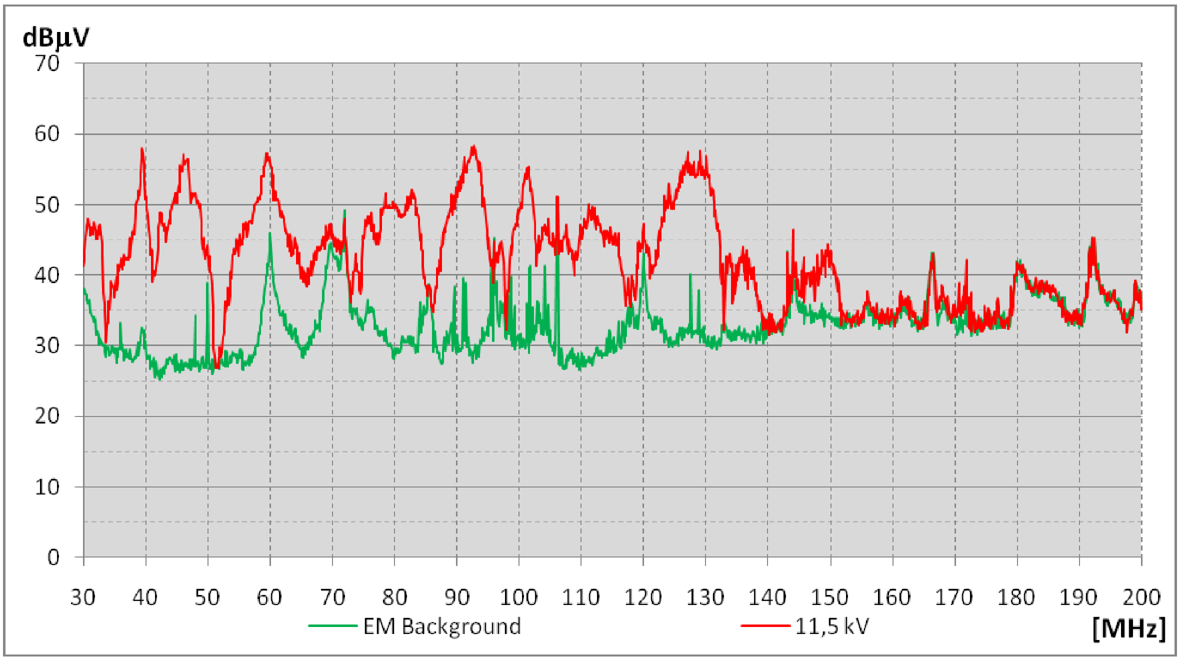

Figure 6 – Electromagnetic emissions at 11.5 kV, horizontal polarization antenna

4.2. Vertical Antenna Polarization

A vertical polarization antenna and the voltage 6.5 kV (Fig. 7.) electromagnetic interference have a different course than the horizontal polarization antenna.

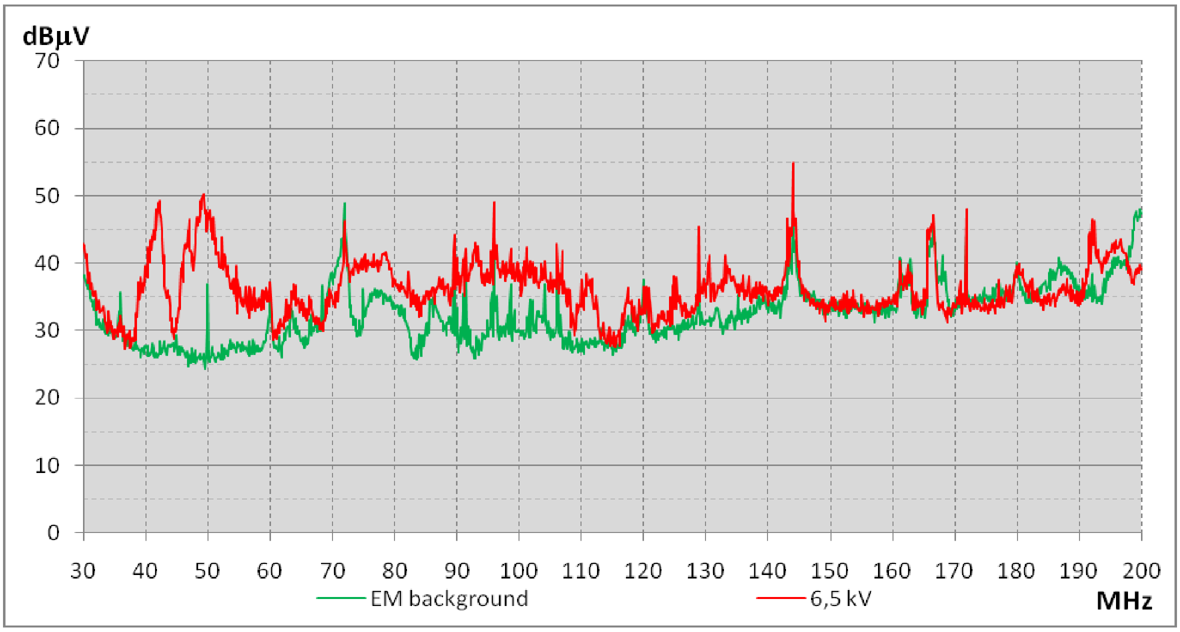

Figure 7 – Electromagnetic emissions at 6.5 kV, vertical polarization antenna

In Fig. 8 it displayed coarse interference at 11.5 kV. There are much more observable differences. The level of interference at lower frequencies, reaching values up to 67 dBμV.

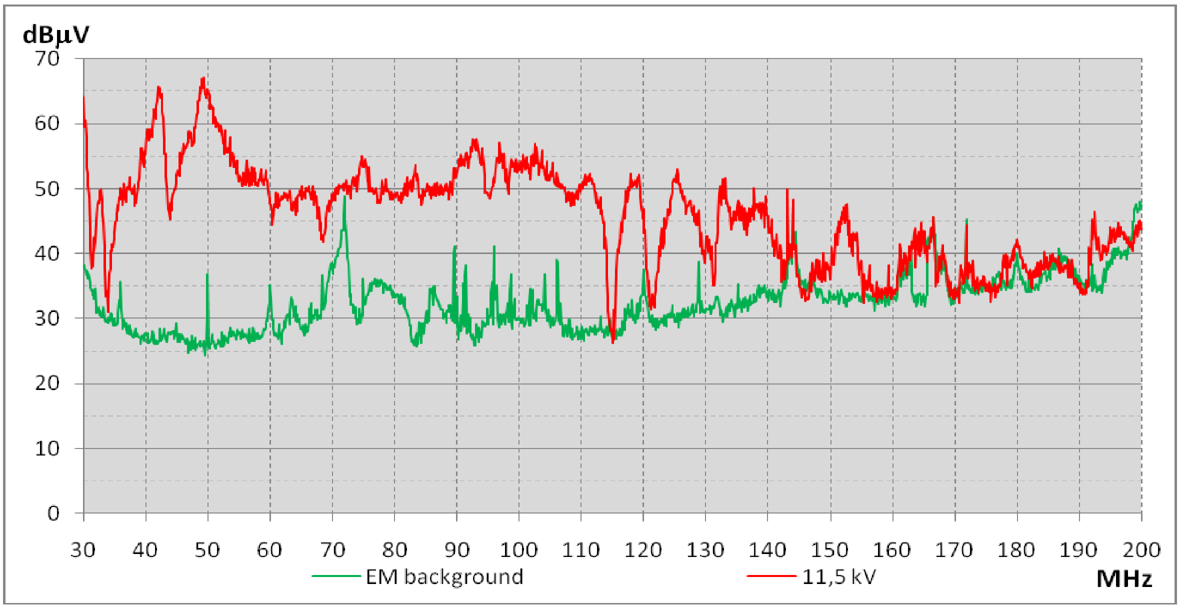

Figure 8 – Electromagnetic emissions at 11.5 kV, vertical polarization antenna

5. CONCLUSION

The measurement results can be stated that the frequency spectrum of corona discharge ranges up to 150 MHz. The increase in Voltage is the increase of ionization in the near of the tip and thereby lengthening cluster corona discharge. Longer clusters of discharges produce higher levels of electromagnetic emissions. Measurements showed the influence of polarization on the receiving antenna interference. The vertical interference reached higher values than the horizontal position.

REFERENCES

[1] *Veverka A.*: Technika vysokých napětí; Praha; SNTL 1978
[2] Akses, A, 2003, Electromagnetic Characteristics of High Voltage DC Corona, 2003 IEEE International Symphosium on Electromagnetic Compatibility, Istambul, Turkey
[3] *Hu Xiaofeng Liu Shanghe Wei Ming Wang Lei*: Measurement and analysis of Electromagnetic Fields Radiated by Corona Discharge, 2007 4th International Symposium on Electromagnetic Compatibility, Qingdao, China
[4] http://home.zcu.cz/~laurenc
[5] *Kysela, A.*: Diplomová práce: Potlačení koróny na vodičích vvn svazkovými vodiči, Plzeň 2009

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