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THE MEASUREMENTS OF CORONA SOUNDS FOR AN ELECTROSTATIC DISCHARGE SYSTEM

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Abstract:

The paper presents some measurements of Corona sounds for an electrostatic discharge system. The electrostatic discharge system it is a model with scale 1:5 for an area from a plate-type electrostatic precipitator section. The electrostatic discharge system has two electrodes: a discharge electrode (a piece from ISODYN B5 discharge wires with five pins) and a plane electrode. The distance between electrodes may be modify up to 50mm and the voltage up to 10kV. Using this electrostatic discharge system and a measuring system with data acquisition card (ADA 3100), may be study the Corona sounds from a plate-type electrostatic precipitator.

Keywords:

Corona, sounds, electrostatic, discharge, system, electrostatic precipitator

1.INTRODUCTION

In a plate-type electrostatic precipitator the dust particles are charged by electrones generated by negative Corona discharge. The Corona discharge depends on the electrical field strength and the shapes of discharge electrodes. The measurements of Corona sounds are often risky for an electronic equipment used in experiments. For a plate-type electrostatic precipitator the distance between the electrodes is up to 0,2 m and the maximum voltage is up to 50kV. The measurements of Corona sounds from a plate-type electrostatic precipitator are difficult to be done. From this reason, it is used an electrostatic discharge system with scale 1:5 for the measurements of Corona currents.

2.THE ELECTROSTATIC DISCHARGE SYSTEM AND THE MEASUREMENT DEVICES

In fig.1 is presented the electrostatic discharge system (EDS) using for experiments. In the left side is the discharge wire with five pins and in the right side is a plane electrode. The electrodes are mounted on electrical insulators (by 20kV).The discharge wires are fixed on textolit base and the plate electrode can be moved up to 50mm. Between the electrodes the voltage is continuous. If the supply of the

discharge wire is with "-" polarity then the supply of the electrode is named negative Corona and if the discharge wire is with "+" polarity then the supply of the electrode is named positive Corona. For the plate-type electrostatic precipitators are used the negative Corona.
The number of free electrons n[-] at the distance r[m] from the Corona negative is:

$$n = e^{\alpha \cdot r} \qquad (1)$$

where $\alpha[m^{-1}]$ is Townsend first coefficient of ionization. The discharge wire is bombarded with the positive ions that emits new electrons starting new avalanche. At higher voltages applied between electrodes appear the Trichel currents with frequency f_t. Between the frequency f_t [Hz] and the Corona currents i[A] is a linear function:

$$f_t = k_w \cdot i \qquad (2)$$

Fig.1. *Electrostatic discharge system*

k_w[Hz/A] is a constant of proportionality. The coefficient k_w depends on pin diameter [1,3]. For the supply of electrostatic discharge system is used the circuit from fig.2.

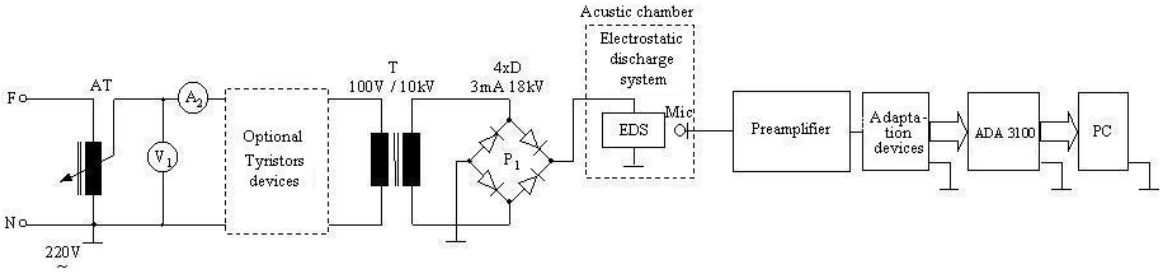
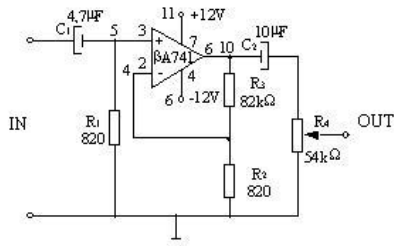


Fig.2. *Electrical circuit that is used to measure the Corona sounds*



In fig.2 are used an autotransformer AT (0÷220V, 50Hz) to modify the voltage on electrode from electrostatic discharge system. Optional, is used a tyristors circuit for modify the voltage's shape and value. To obtain the Corona discharge is used the transformer T (100V/10kV) and the voltage is rectified with high voltage rectifier bridge P_1.

Fig.3. *Electrical circuit of preamplifier*

The Corona sounds from EDS is measured with a precision preamplifier (fig.3) that converts the sounds into voltages. To convert the signal into a voltage that may be measured with the data acquisition card (DAC) ADA 3100, is used an adaptation devices that assures the galvanic separation and convert the voltages. The DAC is connected to a personal computer PC that has a software (Signal View) for processing the signals [2,4]. The measuring sounds must not be disturb by the external perturbation. From this reason, the EDS was introduce into acustic chamber. The preamplifier has an amplification up to 100 that be modify from the resistor R_4.

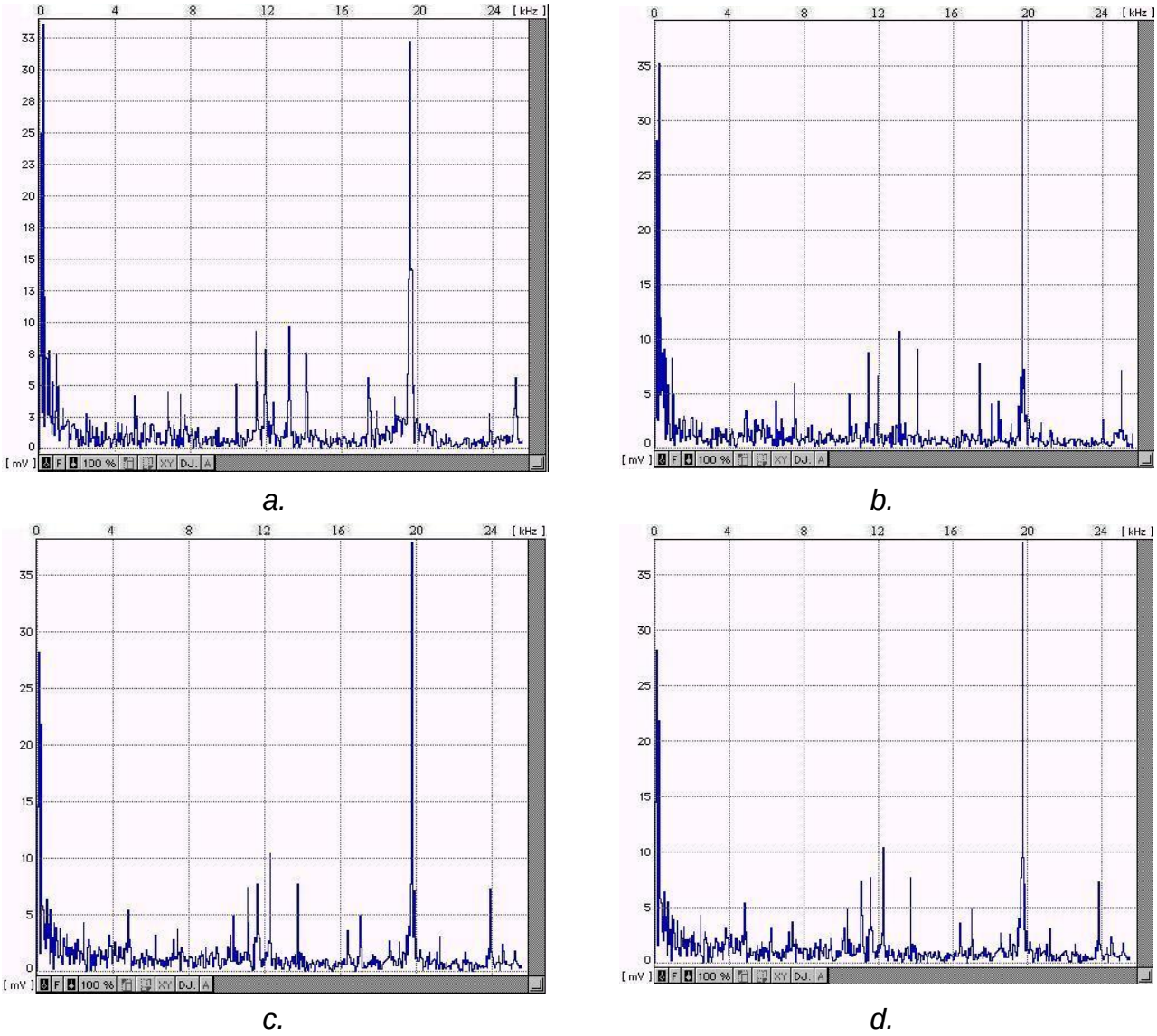
3.THE MEASURING OF CORONA SOUNDS

In fig.2 is presented the positive Corona supply of electrostatic discharge system (+ on the discharge wire). If the bridge P_1 is connected with "-" on the discharge wire then it obtain the negative Corona.

To measuring the Corona sounds was used two cases:

- positive Corona discharge (+ on the discharge wire);
- negative Corona discharge (- on the discharge wire)

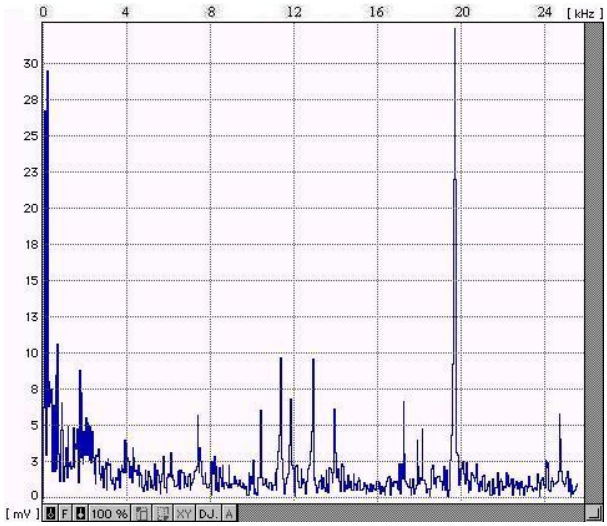
at different distances and voltages between the electrodes of EDS.



a. *b.*

c. *d.*

Fig.4. *Harmonic analyses of Corona sounds at positive Corona (U^+) discharge: a. d=2cm, U^+=4kV; b. d=2cm, U^+=6kV; c. d=2cm, U^+=8kV; d. d=2cm, U^+=10kV*



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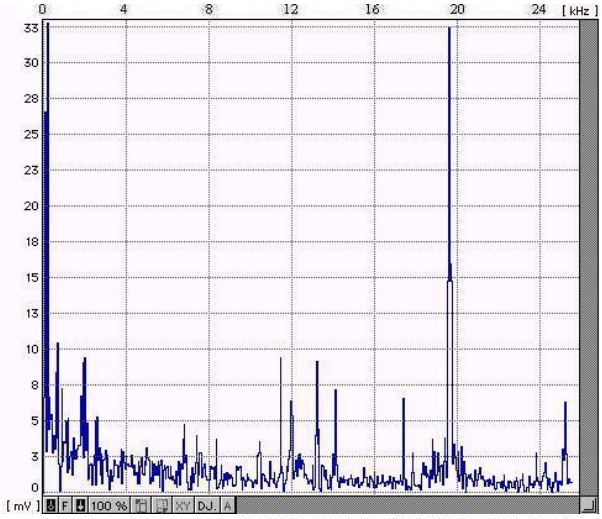
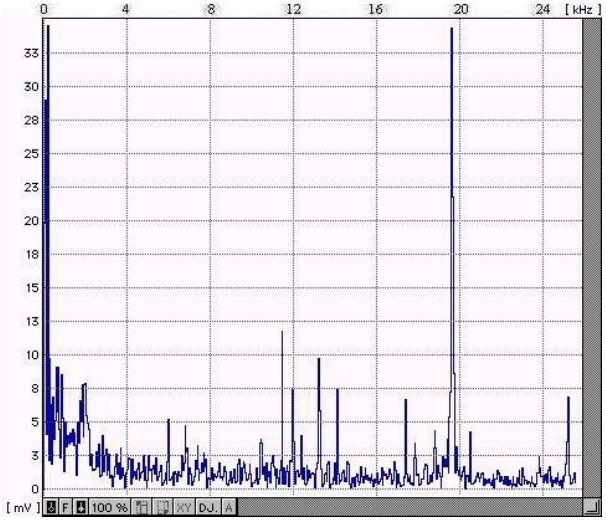
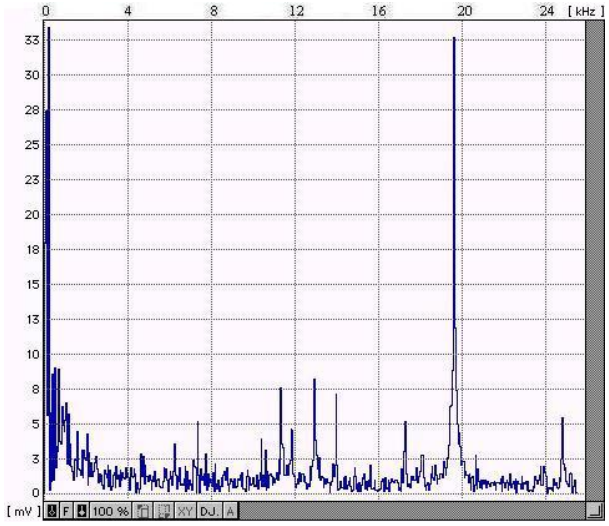


f.

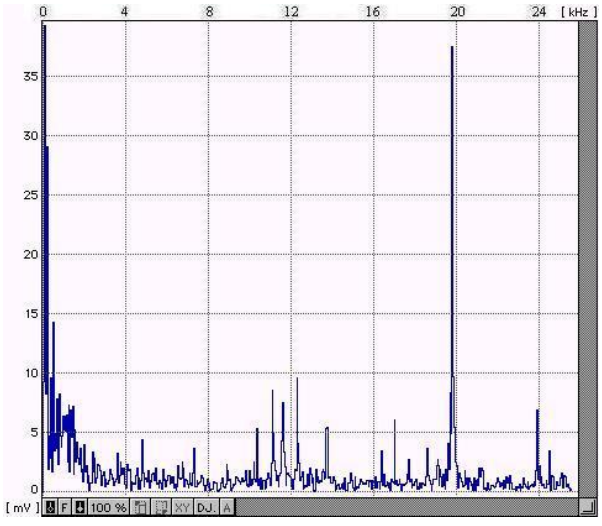


g.

Fig.4. *Harmonic analyses of Corona sounds at positive Corona (U^+) discharge: e. d=3cm, U^+=10kV; f. d=4cm, U^+=10kV; g. d=5cm, U^+=10kV*

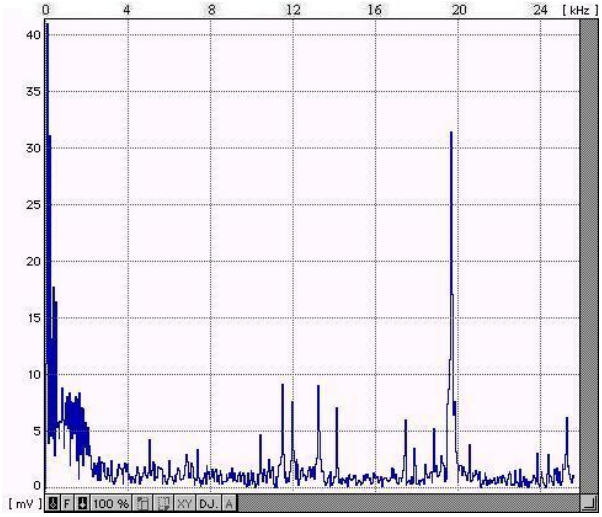


a.

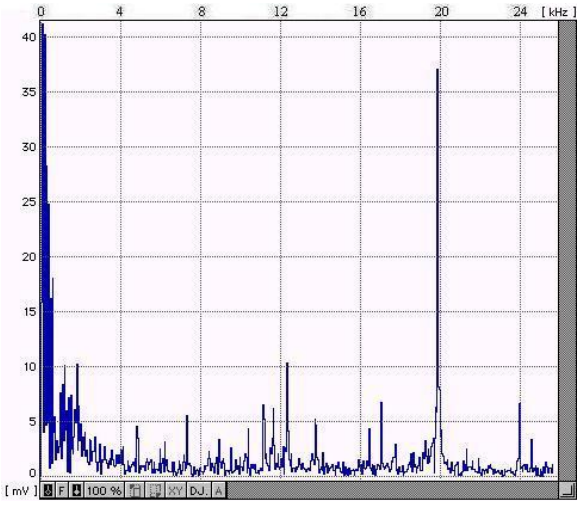


b.

Fig.5. *Harmonic analyses of Corona sounds at negative Corona (U^-) discharge: a. d=2cm, U^-=4kV; b. d=2cm, U^-=6kV*



c.



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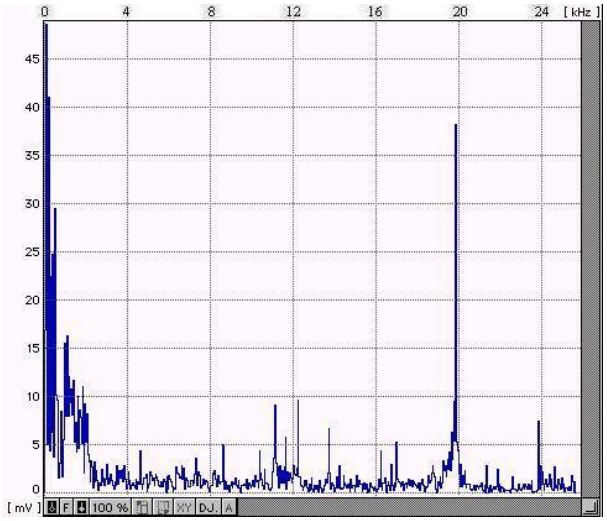

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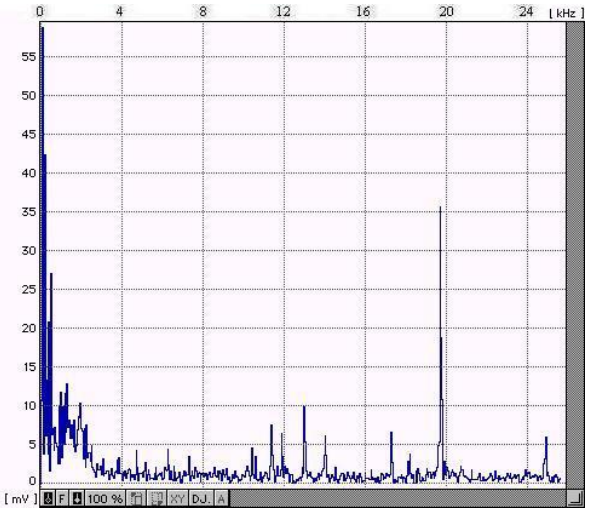
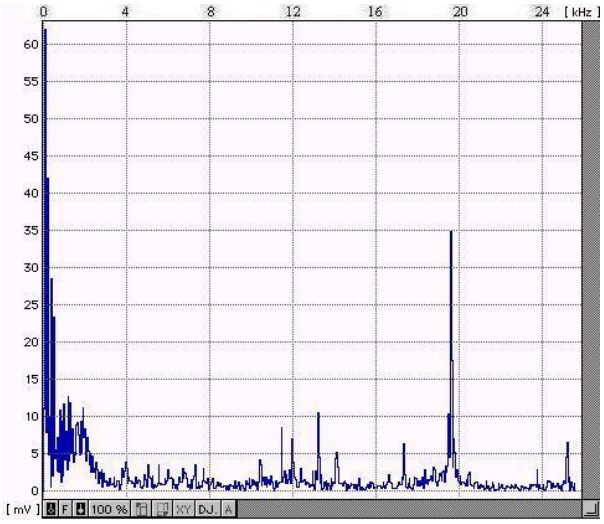


f.



g.

Fig.5. *Harmonic analyses of Corona sounds at negative Corona (U^-) discharge: c. d=2cm, U^-=8kV; d. d=2cm, U^-=10kV; e. d=3cm, U^-=10kV; f. d=4cm, U^-=10kV; g. d=5cm, U^-=10kV*

In the case of positive supply at the distance by 1 cm and the voltage by 7kV, the electrical discharge appears, and in the case of negative supply at the distance by 1 cm and the voltage by 10kV, the electrical discharge does not appear.

4.CONCLUSIONS

In the case of positive Corona (fig.4), for the same distance between the electrodes (d=2 cm) the 19.5kHz harmonic grows up until become constant with the increase of voltage. If it is the same voltage (10kV), the 50Hz harmonic (fundamental) grows up with the distance between the electrodes and 19.5kHz harmonic slows down with the increase of distance between the electrodes.

The fundamental harmonic of the sound (50Hz), in the case of negative Corona (fig.5), in the same conditions, is bigger than in the case of positive Corona. The most important harmonic is that with frequency by 19.5kHz. The 19.5 kHz harmonic has the constant amplitude with the voltage increase, if it is the same distance between electrodes, the 19.5 kHz harmonic slows down. Other harmonics with bigger amplitude have the frequencies by 2kHz, 12kHz and 24kHz.

The 50Hz harmonic has a bigger value in the case of negative Corona, but the 19.5 kHz harmonic has a reverse behaviour. In the both situations, appear Trichel spectrums. The exponential increase and decrease, that are specify for Trichel spectrums, are the same in negative and positive Corona. The appear Trichel spectrums are more visible at 19.5kHz, 12kHz and 25kHz frequency. The harmonic amplitude, in the case of positive Corona are bigger than in the case of negative Corona.

5. REFERENCES

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