WIRELESS ENERGY TRANSFER BY TESLA COIL

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Abstract: The effective wireless transmission of energy was the dream of many scientists and distribution comapanies. Nikola Tesla was the first who dealt with this idea. He created a Tesla Coil and by using them the electrical power was transmitted through air. This wireless transfer reportedly reached the same efficiency as Edison`s direct current transmission. This article is interested in answering the question, if it is even possible to transmit energy by this following device and how high transfer efficiency will be achieved.

Keywords: Tesla Coil, Nikola Tesla, Transfer Energy, Ionosphere, High Frequency Field

1. INTRODUCTION

Nikola Tesla wanted to use the Tesla Coil for wireless transmission energy by the air, but he knew that the best results will be achieved when for transmission will be used the electrical conductive ionosphere. For these reasons, his transformers reached huge sizes. Their produced electric field reached the upper atmosphere. Unfortunately, in terms of university is not possible to construct such a device or power it. For purposes of this article was constructed a small model of the Tesla coil and were measured the necessary measurements.

2. THE SMALL MODEL OF TESLA COIL

For the best results, it was decided to construct two identical transformers – receiver and transmitter. Both are operated on the same resonant (operating) frequency. Furthermore, a IGBT transistor power supply, providing power current with adjustable frequency range from 100 to 250 kHz and with a maximum output of 5 kW. To the test of the efficiency of transfer energy was chosen distance 1 meter between the transmitter and receiver. And the output of receiver was loaded with the bulb 200 W (as resistivite load). The structural design of coils is shown in Figure 1.

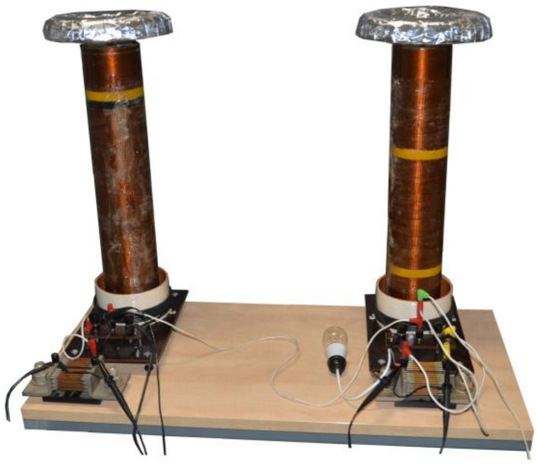

Figure 1: The design of coils

2.1. THE OPERATING CONDITIONS AND OPERATING PRINCIPLES

The Tesla Coil is high frequency transformer without the iron core. It is composed of two concentric coils with the underdense bond. The operation frequency of coil is given by the structural resonance frequency of the secondary coil together with the air capacity – the top metal toroid. The transformation ratio is the ratio of secondary and primary windings. In our case, the primary coil has 5 turns and secondary 1,500 turns. If the primary winding is supplied with current at the same frequency as the resonant frequency of secondary coil, there is the energy transfer between primary and secondary windings. The bottom of secondary windings of transmitter and receiver coils are grounded. So, the maximum inductive voltage and field strength is appeared at the top of secondary winding. If the conditions, that the resonant frequency of the transmitting and receiving coils are the same and the supply current is resonant current, there is a remote – wireless long distance transmission. The induced energy in the secondary winding of the receiver is induced via an air link to the primary winding and the energy goes into the load. But it necessary to say that main art of the energy is transmitted by the electric part of the electromagnetic radiation between the coils. The circuit diagram of transformers including a measurement is shown in Figure 2.

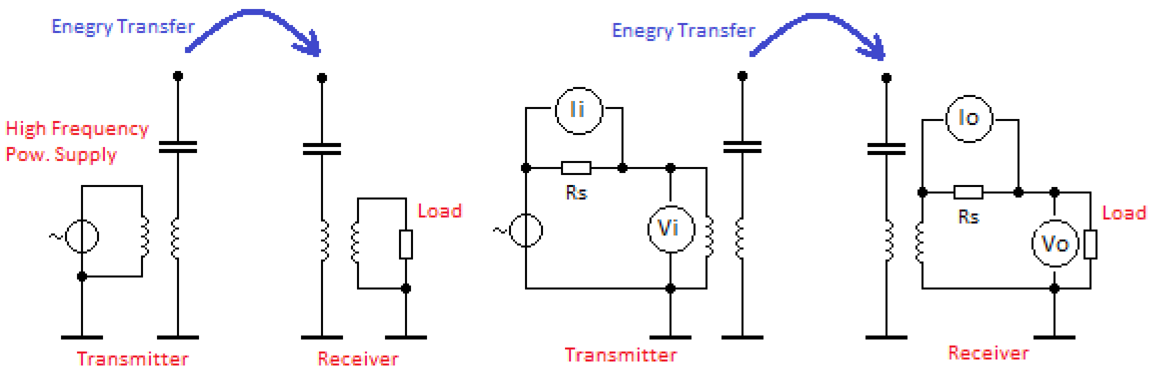

Figure 2: The circuit diagram of the Tesla coils including a measurement

2.2. THE MEASUREMENT OF PARAMETERS

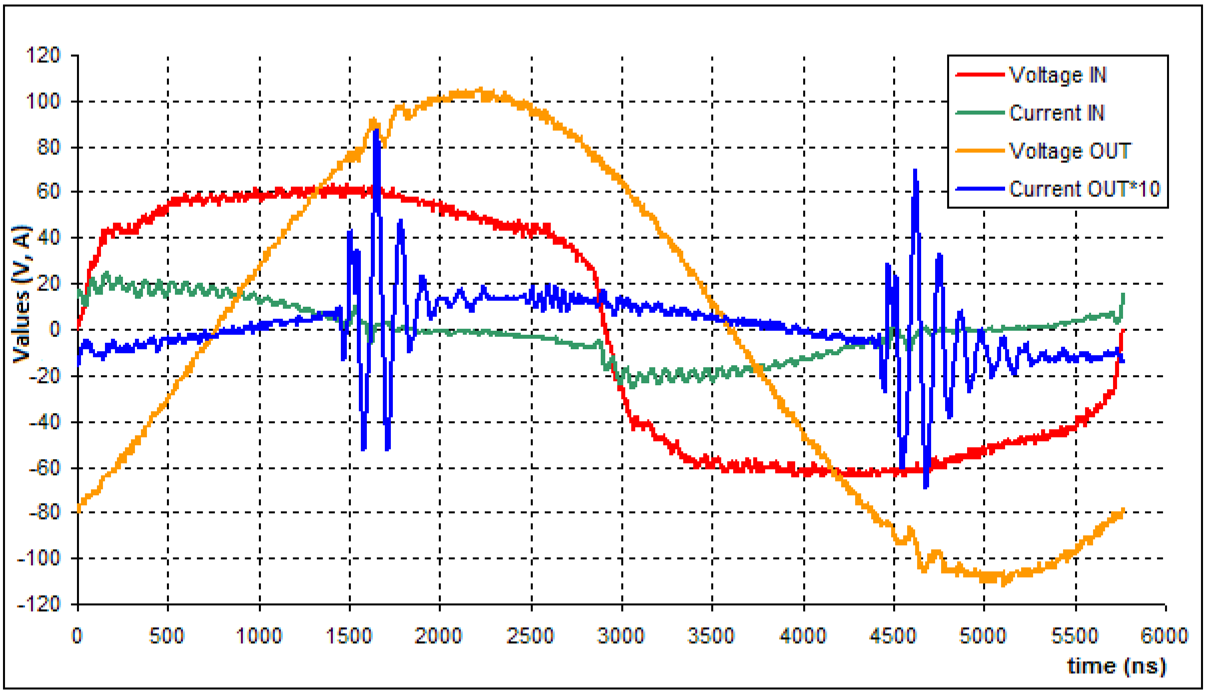

Figure 3: The measured input and output values

The resonant frequency of coils is approximately 180 kHz. The voltage potential at any point of primary circuit does not exceed 100 V, so we can easily directly connect an oscilloscope with a dividing probe for the voltage measurement. The big problem is with the current measurement, because current is oscillated at high frequencies and its accurate measurement would be necessary to use a current probe with an operation frequency of 10 MHz. This problem was easily solved by using a large shunt R_S (no induction) and subsequent voltage measurement (voltage is proportional to the current). The load was 200 W bulb, which behaves is at low frequencies as resistor and at high frequency causes a current shift, due to its inductance. The measurement values of the input and output current and voltages are shown in Figure 3.

2.3. Input and Output Power, Efficiency of Transfer

In the figure 4 are shown waveforms of the input and output power. The mean input power (which is equal to real power) in one period is 776.98 W and output power is 130.8 W. So the total transfer efficiency at distance 1 meter is approximately 16.84 %.

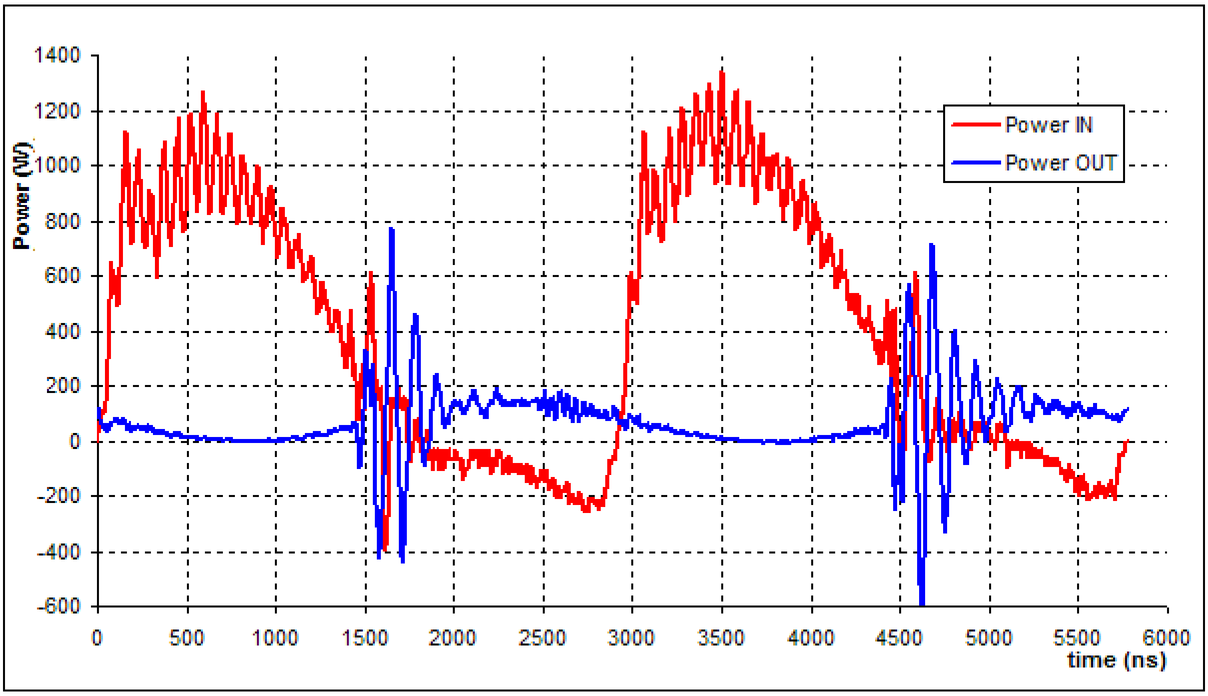

Figure 4: The waveform of input and output

According to the illustrated waveform in the Figure 4 is showed, that each half period of the waveform the energy is alternately transmitted and received. Always the precise tuning of the resonant frequency on both transformers is important. Any deviation from the tuning resonant frequency has a large influence on the resulting transfer efficiency. In out case, tune the deviation is not greater than 5 kHz. By the values of deviation higher than 20 kHz the transfer efficiency is decreased below 10 %. Of course, the transfer efficiencies are also dependent on the transmission distance. When experimental energy was transferred at distance of 600 mm, the efficiency achieved about 20 %. The efficiency of transmission is greatly affected by a load. The ideal case is, when the load is linear and consumed energy is approximately 1/10 to 1/5 of the input power.

2.4. The Electric Field Around The Transformers

Distribution of the electric field around the transformers can by illustrated graphically. The measured values are the intensity of electric field E, the units are kV / mm (MV / m). At the Figure 5 is shown the distribution of the electric field around the transformers in power input of 500 W. The transmitting coil had a small deviation from a perfect tune, so the intensity in its surroundings is lower then at the receiving coil.

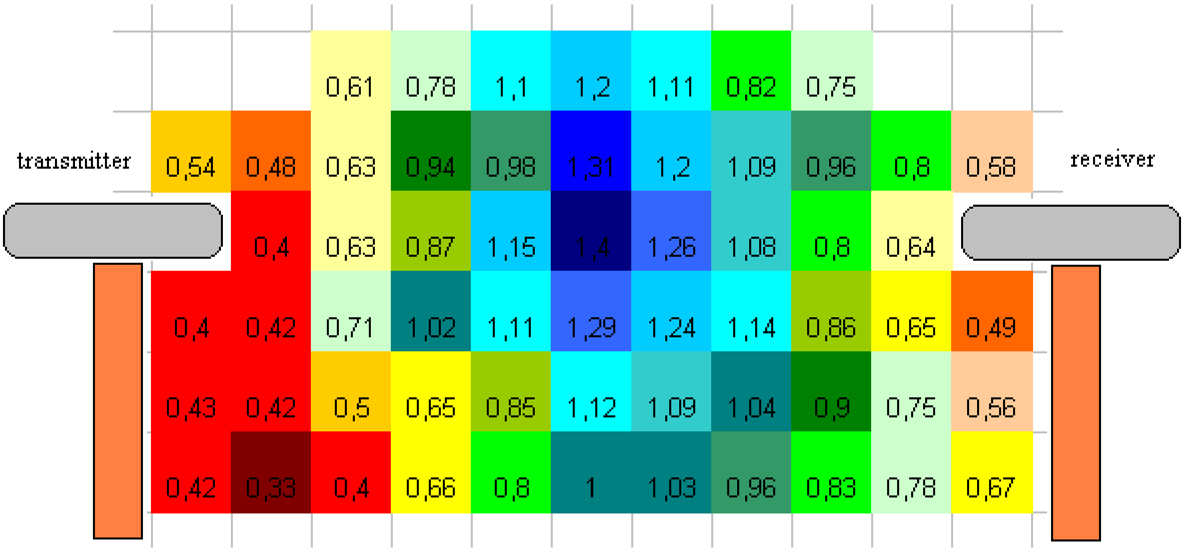

Figure 5: The electric field around the transformers

The energy between coils is transmitted mainly through the electric field. The values of magnetic field are insignificant and, moreover, the measurement of magnetic induction in environment of the high intensity of electric field by common laboratory instruments is immeasurable.

3. CONCLUSION

The Tesla Coil (or Tesla Transformer) is not probably the most effective device for wireless energy transfer. The comparable modern devices allow transfer energy with efficiency of 80 % and higher. However, this is a device, which transmission power is basically unlimited. And when we use for the transfer the ionosphere, as Nikola Tesla, enough power can be transmitted to any place on the Earth. However these remote energy transfer experiments at long distance are not verified by the modern laboratory equipments, so they are seen as fantasy and science fiction.

ACKNOWLEDGEMENT

This paper contains the results of research works funded from project of specific research program of Brno University of Technology No. FEKT-S-11-19. The research was performed in Center for Research and Utilization of Renewable Energy Sources. Authors gratefully acknowledge financial support from European Regional Development Fund under project No. CZ.1.05/2.1.00/01.0014.

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