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VARIATION IN THE RADIUS OF COIL AND ITS INFLUENCE ON WIRELESS POWER TRANSMISSION THROUGH MUTUAL INDUCTANCE

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ABSTRACT

Recently, the transmission of electricity without wires has become a trendier and a popular technique. The usual method of electricity transmission has various loss factors, which include transmission losses, grid losses etc. To overcome these losses, wireless electricity transmission could be one of the better substitution routes. Herein we report that the effect on the wireless power transmission by varying the radius of both transmitting and the receiving coil with the concept of mutual induction and modeling a low-cost, environment-friendly and efficient model. This paper gives an idea about various methods of wireless power transmission and mainly emphasizes on non-radiative methods of power transmission along with the practical approach towards it.

Keywords: WiTricity, mutual induction, electromagnetic coupling, induced flux distance, thickness of the coil.

1. INTRODUCTION

Wireless electricity (WiTricity) is the method of transmission of electricity without wires i.e., either by the electromagnetic induction or electromagnetic transmission. Even though the initial stepping stones were laid by Michel Faraday long back by the theory of electromagnetic induction, the first practical demonstration of it was showed by Nikola Tesla in 1891 [1]. The concept of WiTricity is reframed in 2007 by a team of scientists at MIT under the guidance of a professor M. Soljacic and succeeded in transmitting electricity at about 2 meters by illuminating a bulb of 60 W with the efficiency of 40% [2, 3]. This technology might play a vital role in solving various hazards in the transmission of electricity through wires, such as grid losses, transmission losses etc... In this regard, many companies such as TOYOTA, AUDI, INTEL, HAIDER, HFOXCONN, SCHLUMBER, OMNES, and LAMBORGHINI are working to apprehend this technology and to provide their customers improved facilities [4]. Mutual induction is a method in which rate of change of magnetic flux of primary induces an emf in the secondary. This method is short range and the current decays vary fast when compared with other methods of transmission [5]. Mutual induction is influenced by the various factors such as distance, frequency, permeability of core and number of turns and etc., In particular, it decreases with increase in distance [6], increases with increase in permeability of the core material [7], increases with increase in a number of turns and also increases with increase in flux linkage. Our paper is mainly focused on obtaining a better output from the lesser input. This paper is mainly concerned with building a low cost, efficient model of WiTricity and to study the effect on mutual induction when the radius (thickness) parameters are varied and also to comment on that, which could be the better factor for battening the efficiency and the induced distance of mutual induction in wireless power transmission.

2. PASSIVE ELEMENTS AND EXPERIMENTAL SETUP

The passive elements used in the present work are regulated 1.5 DC source, bipolar junction NPN transistor [2N3904], a resistor of 1 K ohm, copper coils, red LED.

The circuit connection is shown in Figure 1. It consists of a regulated 1.5 V DC source, its one end is fed to the transistor in order to convert the regulated DC voltage to fluctuating AC voltage and another end to the coil. The coil is connected to a resistor in order to control the flow of the current through it. Copper coils are used for the purpose of induction, as it has a better electrical conductivity than aluminum and other metals (except silver and gold that are very costly), better thermal conductivity and lesser corrosive. The receiving coil is connected to a 5 mm red LED. It has 1.6 V forward voltages and red light has the least scattering property.

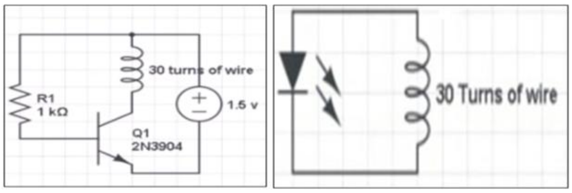

Figure 1 (a) Transmitting circuit, (b) Receiving circuit.

3. RESULTS AND DISCUSSION

Initially, a circuit connection is made according to the set up as shown in Figure 1. When the current flows through the transmitting coil, it produces a time varying magnetic field around it as a result of this varying magnetic field is induced in the receiving coil in the form of emf (Faraday's law). When the current flows through LED it glows.

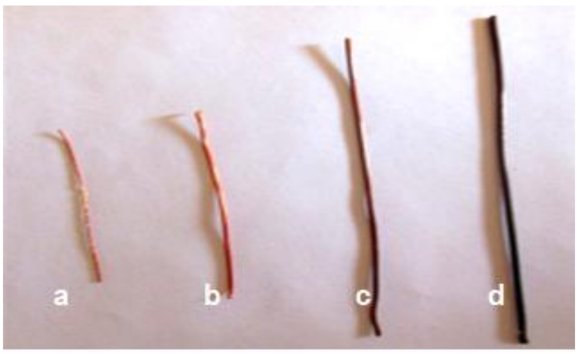

Figure 2: Photocopy of wires having different thickness (radius) (a) 0.04 mm, (b) 0.15 mm, (c) 0.45 mm, (d) 0.75 mm.

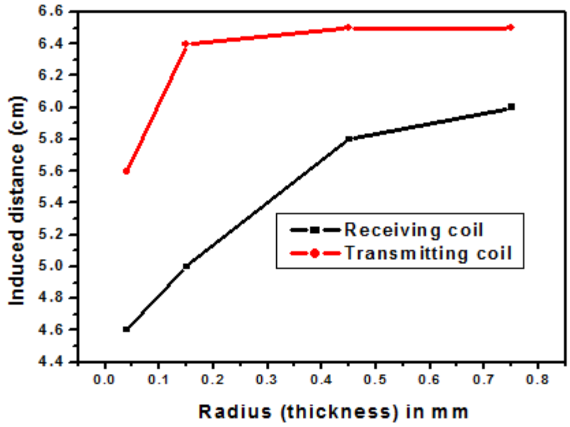

Figure 3: The graph of radius versus induced distance

Table 1: Radius, the distance obtained for transmitting coil and distance obtained for receiving coil.

Radius(Thickness) in mm	Distance obtained for transmitting coil in cm	Distance obtained for receiving coil in cm
0.04	5.6	4.6
0.15	6.4	5.0
0.45	6.5	5.6
0.75	6.6	6.0

The photocopy of different thickness as shown in Figure 2. The radius of the coils and distance obtained for transmitting and receiving coils are shown in Table 1. It is observed from the Table 1 that induced distance for transmitting coil and receiving coil increases as the thickness of the coil increased. The graph of radius versus induced distance for transmitting and receiving coils are shown in Figure 3. It is observed from the Figure 3 that the induced distance for transmitting coil is higher than the receiving coil and for 0.75 mm thickness the induced distance is maximum for both the coils. Thus, we can conclude that by varying the thickness of transmitter coil we get better-induced emf than receiver coil. Therefore, mutual induction can be enhanced by selecting a better thickness primary coil of appropriate value.

4. CONCLUSION

We have successfully designed and set up a low-cost, environment-friendly and efficient model of WiTricity. We obtained the power transmission for different radius for transmitting and receiving coils. Herein observed that as the radius of transmitting and the receiving coils are increased the obtained power transmission are increased and it is maximum for larger radius i.e., for 0.75 mm. By comparing power transmission obtained for different radius of transmitting and receiving coils, we can depict that the transmitting coil of the appropriate radius can induce better than the receiving coil of the same thickness. Applications of this model are limitless; this can be used for mobile and laptop charging, wireless television, hospitals etc., the only limit is our imagination.

5. ACKNOWLEDGMENT

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