

Wireless Power Transmission

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Abstract:—In this paper, we present the concept of transmitting power without using wires i.e., transmitting power as microwaves from one place to another in order to reduce the transmission and distribution losses. This concept is known as Microwave Power transmission (MPT). We also discussed the technological developments in Wireless Power Transmission (WPT). The advantages, disadvantages, biological impacts and applications of WPT are also presented.

Index Terms—Microwave Power transmission (MPT), Solar Power Satellites (SPS), Wireless Power Transmission (WPT)

I. INTRODUCTION:

Wireless energy transmission (WPT) or WiTricity is the process of transmission of energy from one place to another without using wires. Mostly energy transfer is done using wires. The energy loss is mostly during transmission. The energy loss exceed 40% (in India) [1]. So the efficiency counts about to 50-60%. The main reason for the energy loss is due to resistance of the wire. It can be improved to a certain level by using underground cables made of high temperature superconductors. But the transmission is still inefficient.

A solution for this problem is the method of wireless power transmission (i.e. without wires). Its efficiency is around 80%. The methods of achieving WPT are resonant inductive coupling (RIC), electromagnetic radiations such as microwaves or lasers. RIC can be used only for a short distance transmission. As lasers are hazardous it is not used. But microwaves are safe for living beings upto a certain frequency. Hence microwaves are mostly used.

II. WIRELESS POWER TRANSMISSION:

In this paper, we are going to discuss about wireless power transmission using microwaves. Microwave power Transmission is the process of using microwaves in transmission of power through outer space without the need of wires. Following World War II which saw the development of high power microwave emitters also known as cavity magnetrons, the idea of using microwaves to transmit power was researched.

The only condition that has to be satisfied is the line of sight between the source and the receiver. The steps involved in MPT are as follows:

- i. Converting electrical energy into microwave energy.
- ii. Capturing microwaves using rectenna (rectifying antenna)
- iii. Converting microwave energy back to electrical energy.

III. WIRELESS POWER TRANSMISSION SYSTEM

The concept of Wireless Power Transmission System can be explained as follows: In the transmission side, the microwave power source generates microwave power and the output power is controlled by electronic control circuits. The wave guide ferrite circulator which protects the microwave source from reflected power is connected with the microwave power source through the Coax – Waveguide Adaptor. The tuner matches the impedance between the transmitting antenna and the microwave source. The attenuated signals will be then separated based on the direction of signal propagation by Directional Coupler. The transmitting antenna radiates the power uniformly through free space to the rectenna. In the receiving side, a rectenna receives the transmitted power and converts the microwave

power into DC power. The impedance matching circuit and filter is provided to setting the output impedance of a signal source equal to the rectifying circuit. The rectifying circuit consists of Schottky barrier diodes converts the received microwave power into DC power.

3.1 Components of WPT System

The Primary components of Wireless Power Transmission are Microwave Generator, Transmitting antenna and Receiving antenna (Rectenna). The components are described in this chapter.

3.1.1 Microwave Generator

The microwave transmitting devices are classified as Microwave Vacuum Tubes (magnetron, klystron, Travelling Wave Tube (TWT), and Microwave Power Module (MPM)) and Semiconductor Microwave transmitters (GaAs MESFET, GaN pHEMT, SiC MESFET, AlGaIn/GaN HFET, and InGaAs). Magnetron is widely used for experimentation of WPT. The microwave transmission often uses 2.45GHz or 5.8GHz of ISM band. The other choices of frequencies are 8.5 GHz [2], 10 GHz [3] and 35 GHz [4]. The highest efficiency over 90% is achieved at 2.45 GHz [4] among all the frequencies.

3.1.2 Transmitting antenna

The slotted wave guide antenna, micro strip patch antenna, and parabolic dish antenna are the most popular type of transmitting antenna. The slotted waveguide antenna is ideal for power transmission because of its high aperture efficiency (> 95%) and high power handling capability.

3.1.3 Rectenna

The rectenna is a passive element consists of antenna, rectifying circuit with a low pass filter between the antennas and rectifying diode. The antenna used in rectenna may be dipole, microstrip or parabolic dish antenna.[5] The patch dipole antenna achieved the highest efficiency among the all. The performance of various printed rectenna . Schottky barrier diodes (GaAs-W, Si, and GaAs) are usually used in the rectifying circuit due to the faster reverse recovery time and much lower forward voltage drop and good RF characteristics.

IV: ADVANTAGES, DISADVANTAGES, AND BIOLOGICAL IMPACTS OF WPT

4.1 Advantages:

Wireless Power Transmission system would completely eliminates the existing high-tension power transmission line cables, towers and sub stations between the generating station and consumers and facilitates the interconnection of electrical generation plants on a global scale. It has more freedom of choice of both receiver and transmitters. Even mobile transmitters and receivers can be chosen for the WPT system. The cost of transmission and distribution become less and the cost of electrical energy for the consumer also would be reduced. The power could be transmitted to the places where the wired transmission is not possible. Loss of transmission is negligible level in the Wireless Power Transmission; therefore, the efficiency of this method is very much higher than the wired transmission. Power is available at the rectenna as long as the WPT is operating. The power failure due to short circuit and fault on cables would never exist in the transmission and power theft would be not possible at all.

4.2 Disadvantages:

The Capital Cost for practical implementation of WPT seems to be very high and the other disadvantage of the concept is interference of microwave with present communication systems.

4.3 Biological Impacts:

Common beliefs fear the effect of microwave radiation. But the studies in this domain repeatedly proves that the microwave radiation level would be never higher than the dose received while opening the microwave oven door, meaning it is slightly higher than the emissions created by cellular telephones.[6] Cellular telephones operate with power densities at or below the ANSI/IEEE exposure standards .[7] Thus public exposure to WPT fields would also be below existing safety guidelines.

V. APPLICATIONS OF WPT

Generating power by placing satellites with giant solar arrays in Geosynchronous Earth Orbit and transmitting the power as microwaves to the earth known as Solar Power Satellites (SPS) is the largest application of WPT. Another application of WPT is moving targets such as fuel free airplanes, fuel free electric vehicles, moving robots and fuel free rockets. The other applications of WPT are Ubiquitous Power Source (or) Wireless Power Source, Wireless sensors and RF Power Adaptive Rectifying Circuits (PARC).

CONCLUSION

The concept of Microwave Power transmission (MPT) and Wireless Power Transmission system is presented. The technological developments in Wireless Power Transmission (WPT), the advantages, disadvantages, biological impacts and applications of WPT are also discussed.

This concept offers greater possibilities for transmitting power with negligible losses and ease of transmission than any invention or discovery heretofore made. Dr. Neville of NASA states "You don't need cables, pipes, or copper wires to receive power. We can send it to you like a cell phone call – where you want it, when you want it, in real time". We can expect with certitude that in next few years' wonders will be wrought by its applications if all the conditions are favorable.

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