COUPLED WIRELESS CHARGING SYSTEM FOR ELECTRICAL VEHICLES BY USING SOLAR PANEL

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ABSTRACT

The automotive industry has witnessed a surge in electric vehicles (EVs) over the past decade, with battery charging systems utilizing solar panels playing a pivotal role in their development. EVs have emerged as energy-efficient alternatives to combustion engine vehicles, offering increased reliability, range, and performance. Introducing wireless charging, particularly through solar panels, enhances the accessibility of EVs, making them more user-friendly. Wireless power transfer technology, particularly magnetic resonant coupling, is discussed in this paper, highlighting its efficiency and practical applications in EVs. The analysis also delves into the impact of separation on the efficiency of wireless power transfer. Key terms include Wireless Power Transfer (WPT), Magnetic Resonance Coupling, Solar Panel, Electric Vehicles, Transmission Efficiency, Impedance Matching, Coupling Coefficient, and Wireless Charging.

Keywords: Wireless Power Transfer (WPT), Magnetic Resonance Coupling, Solar Panel, Electric Vehicles

1. INTRODUCTION

The automotive industry has shifted towards eco-friendly options, particularly electric vehicles (EVs), which utilize one or more traction motors for propulsion. These vehicles rely on a collector system to draw electricity from distant power sources, powering them through large traction batteries that require connection to a charging outlet. However, EV batteries are less dense and efficient compared to gasoline-powered engines, presenting a challenge. Wireless power transfer (WPT) offers a solution by eliminating cables and infrastructure, enhancing mobility within transmission range, and addressing power plug compatibility issues. This paper proposes a high-efficiency wireless charging system for EVs, focusing on magnetic resonant coupling, a highly effective WPT method that creates resonance for power transmission without electromagnetic wave radiation.

The resonance frequency plays a crucial role in circuit design, aiming to achieve maximum power transfer efficiency by matching impedances on the primary and secondary sides of the WPT system. However, as the technology operates within the megahertz range, the usable frequency is limited by the Industrial Scientific and Medical (ISM) band, necessitating fixation within this band.

Types of charging systems for EVs include Level 1, Level 2, and Level 3 charging, each offering varying charging speeds and capabilities. Additionally, wireless charging allows for convenient charging without physical plug-in, utilizing charging pads installed on the ground and underside of the EV. Vehicle-to-Grid (V2G) charging technology enables bidirectional power flow between EVs and the electric grid, facilitating grid stabilization and load balancing.

Wireless charging systems for EVs typically involve several components, including a solar panel to generate DC power, a battery for energy storage, and a transformer to convert DC to AC. The transmitting circuit comprises a resistor, capacitor, and transmitting coil, while the receiving coil collects transmitted power. Both coils are circular planar copper coils, with the receiving side including a resistor and capacitor in parallel for load-side AC to DC conversion.

2. RELATED MODEL DESCRPTION

The working principle of a solar panel is based on the photovoltaic effect, which is the process by which sunlight is converted into electricity. Here's a simplified explanation of how solar panels work:

1. Photon Absorption: When sunlight, which is composed of tiny particles called photons, strikes the surface of a solar panel, some of these photons are absorbed by the semiconductor material within the solar cells.

2. Electron Excitation: The absorbed photons transfer their energy to electrons within the semiconductor material, causing them to become "excited" and break free from their atomic bonds, creating electron-hole pairs.

3. Electron Flow: Due to the internal structure of the solar cell, an electric field is established within the material. This electric field acts as a driving force, causing the excited electrons to move in a specific direction towards the front surface of the cell.

4. Electricity Generation: As the excited electrons move towards the front surface of the solar cell, they create a flow of electric current. Metal contacts on the front and back of the solar cell collect this current, allowing it to be drawn off as electricity.

5. Direct Current (DC) Output: The electricity generated by a single solar cell is in the form of direct current (DC). Multiple solar cells are connected together in a solar panel to increase the overall power output. The combined DC electricity generated by the solar panel can then be used to power electrical loads directly or stored in batteries for later use.

6. Inverter Conversion: Since most household and commercial electrical systems operate on alternating current (AC), the DC electricity generated by solar panels needs to be converted into AC using an inverter before it can be used to power common appliances and devices.

7. Grid Connection (Optional): In grid-connected solar power systems, any excess electricity generated by the solar panels can be fed back into the electrical grid, often through a process called net metering. This allows solar panel owners to earn credits or compensation for the surplus electricity they produce.

3. IMPLMENTATION STUDY

3D MODELLING OF COILS FOR POWER TRANSFER

The 3-dimensional modelling of the transmitter and receiver coil is done using the ANSYS Maxwell software. A transparent rectangular plate is placed in between the transmitting and receiving coils to capture the magnetic fields that exist between the coils. A higher coupling coefficient is acquired, as both the coils has identical dimensions

3.1 PROPOSED MODEL

While half-wave and full-wave rectification suffice to deliver a form of DC output, neither produces constant-voltage DC. In order to produce steady DC from a rectified AC supply, a smoothing circuit or filter is required.[1] In its simplest form this can be just a reservoir capacitor or smoothing capacitor, placed at the DC output of the rectifier. There will remain an amount of AC ripple voltage where the voltage is not completely smoothed. A half-wave rectifier will only give one peak per cycle and for this and other reasons is only used in very small power supplies. A full wave rectifier achieves two peaks per cycle and this is the best that can be done with single-phase input. For three-phase inputs a three-phase bridge will give six peaks per cycle and even higher numbers of peaks can be achieved by using transformer networks placed before the rectifier to convert to a higher phase order.

To further reduce this ripple, a capacitor-input filter can be used. This complements the reservoir capacitor with a choke (inductor) and a second filter capacitor, so that a steadier DC output can be obtained across the terminals of the filter capacitor. The choke presents a high impedance to the ripple current.

4. METHODOLOGIES

Synchronous condenser.

A synchronous motor takes a leading current when over-excited and, therefore, behaves as a capacitor. An over-excited synchronous motor running on no load is known as synchronous condenser. When such a machine is connected in parallel with the supply, it takes a leading current which partly neutralises the lagging reactive component of the load. Thus, the power factor is improved. Fig 6.5 shows the power factor improvement by synchronous condenser method. The 3φ load takes current IL at low lagging power factor cos φL. The synchronous condenser takes a current Im which leads the voltage by an angle φm*. The resultant current I is the phasor sum of Im and IL and lags behind the voltage by an angle φ. Φ is less than φL so that cos φ is greater than cos φL. Thus, the power factor is increased from cos φL to cos φ. Synchronous condensers are generally used at major bulk supply substations for power factor improvement.

Phase advancers.

Phase advancers are used to improve the power factor of induction motors. The low power factor of an induction motor is since its stator winding draws exciting current which lags the supply voltage by 90o. If the exciting ampere turns can be provided from some other ac source, then the stator winding will be relieved of exciting current and the power factor of the motor can be improved. This job is accomplished by the phase advancer which is simply an ac exciter. The phase advancer is mounted on the same shaft as the main motor and is connected in the rotor circuit of the motor. It provides exciting ampere turns to the rotor circuit at slip frequency. By providing more ampere turns than required, the induction motor can be made to operate on leading power factor like an over-excited synchronous motor. Phase advancers have two principal advantages. Firstly, as the exciting ampere turns are supplied at slip frequency, therefore, lagging kVAR drawn by the motor are considerably reduced. Secondly, phase advancer can be conveniently used where the use of synchronous motors is inadmissible. However, the major disadvantage of phase advancers is that they are not economical for motors below 200 H.P.

AC-DC CONVERTER A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), current that flows in only one direction, a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid state diodes, vacuum tube diodes, mercury arc valves, and other components.A device which performs the opposite function (converting DC to AC) is known as an inverter.When only one diode is used to rectify AC (by blocking the negative or positive portion of the waveform), the difference between the term diode and the term rectifier is merely one of usage, i.e., the term rectifier describes a diode that is being used to convert AC to DC. Almost all rectifiers comprise a number of diodes in a specific arrangement for more efficiently converting AC to DC than is possible with only one diode. Before the development of silicon semiconductor rectifiers, vacuum tube diodes and copper(I) oxide or selenium rectifier stacks were used.

HALF-WAVE RECTIFIER:

In half wave rectification, either the positive or negative half of the AC wave is passed, while the other half is blocked. Because only one half of the input waveform reaches the output, it is very inefficient if used for power transfer. Half-wave rectification can be achieved with a single diode in a one-phase supply, or with three diodes in a three-phase supply.

5 RESULTS AND DISCUSSION SCREEN SHOTS

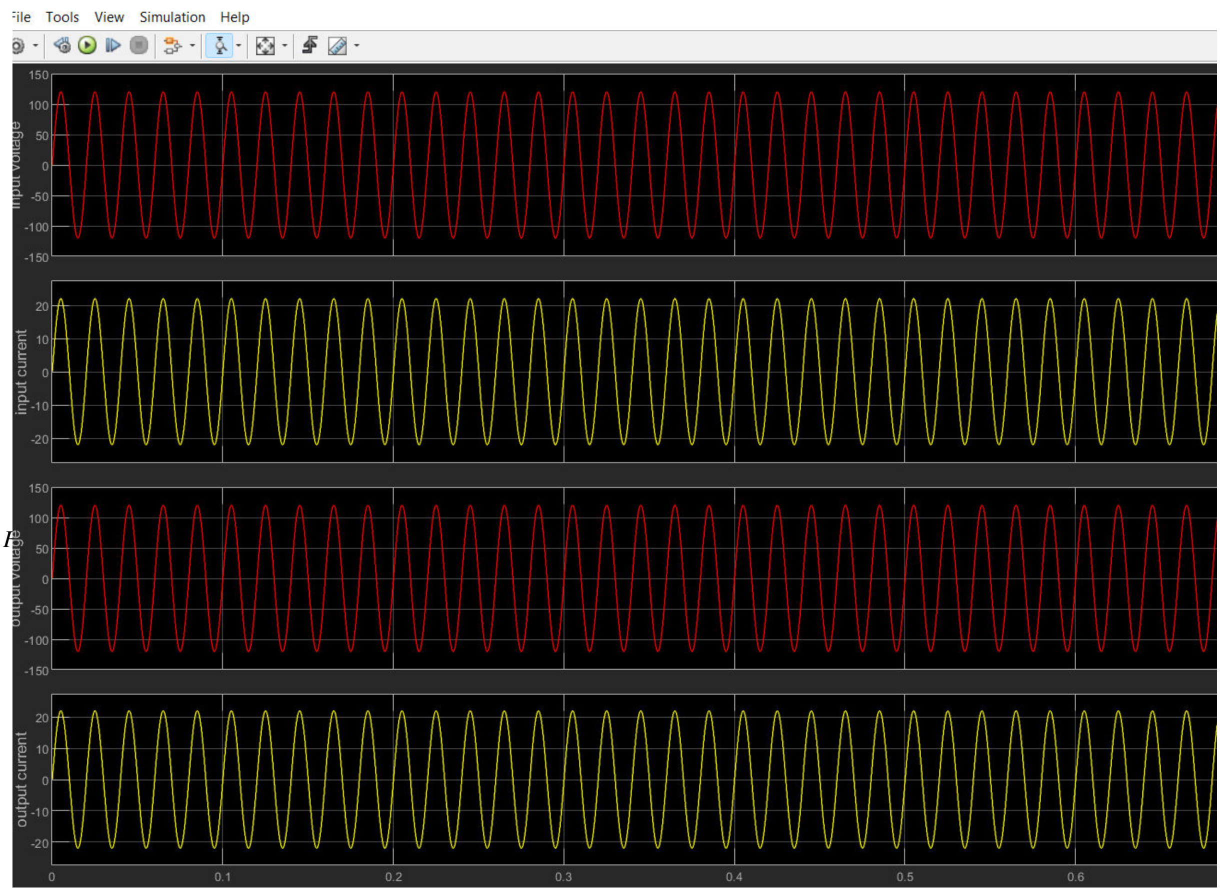

Figure 1 OUT PUT WAVEFORM

6. CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

After plotting the I-V and P-V curves of solar cell by varying two main parameters, it was found that the solar radiation directly affects the solar cell power and the open circuit voltage. The radiation values were changed in the range of 400W/m2 to 1000W/m2 and output current and voltage behaviours were observed. However, there is a noticeable effect on the photocurrent. Secondly, increase in temperature decreases the open circuit voltage of cell. The temperature is varied from 250C to 420C, the maximum power point of solar cell array can be traced using these curves. It is concluded that these results are helpful to study the behaviour of solar cell and the model can be upgraded to solar module (196 cells) and then several MPPT techniques can be applied to get the maximum efficiency out of solar module.

6.2 FUTURE SCOPE

The Future of Solar Energy considers only the two widely recognized classes of technologies for converting solar energy into electricity — photovoltaics (PV) and concentrated solar power (CSP), sometimes called solar thermal) — in their current and plausible future forms. Because energy supply facilities typically last several decades, technologies in these classes will dominate solar-powered generation between now and 2050, and we do not attempt to look beyond that date. In contrast to some earlier Future of studies, we also present no forecasts — for two reasons. First, expanding the solar industry dramatically from its relatively tiny current scale may produce changes we do not pretend to be able to foresee today. Second, we recognize that future solar deployment will depend heavily on uncertain future market conditions and public policies — including but not limited to policies aimed at mitigating global climate change.

As in other studies in this series, our primary aim is to inform decision-makers in the developed world, particularly the United States. We concentrate on the use of grid-connected solar-powered generators to replace conventional sources of electricity. For the more than one billion people in the developing world who lack access to a reliable electric grid, the cost of small-scale PV generation is often outweighed by the very high value of access to electricity for lighting and charging mobile telephone and radio batteries. In addition, in some developing nations it may be economic to use solar generation to reduce reliance on imported oil, particularly if that oil must be moved by truck to remote generator sites. A companion working paper discusses both these valuable roles for solar energy in the developing world.

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