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Electrical Vehicles Wireless Charging System

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ABSTRACT

These days, Electric cars are taking the place of traditional cars that run on gasoline or diesel. EVs get their power from batteries, which need to be charged when they run out of power. The EV's battery range may be between 100 and 200 km, therefore when we go more than that, we have to charge the batteries. These charging systems need to be entirely automated. For example, when an electric vehicle (EV) pulls up to a charging station, it should immediately get charged by parking in a place where it can transmit energy wirelessly. This will be a very easy way to charge an electric car.

The core idea behind wireless charging is the same as how a transformer works. In wireless charging, there is a transmitter and a receiver. The 220v, 50Hz power source is changed into high-frequency AC, which is then sent to the transmitter coil. This creates an alternating magnetic field that cuts the receiver coil and makes it produce AC power. But for wireless charging to work well, it's vital to keep the resonance frequency between the transmitter and the receiver. On both sides, compensation networks are included so that the resonant frequencies stay the same. Then, at the receiver side, the AC power was converted to DC and sent to the battery using the Battery Management System. (BMS).

KEYWORDS: *Blended fuel, Jatropha curcas oil, Candida antarctica, Biodiesel*

1. INTRODUCTION

The Indian government says that by the end of 2021, electric vehicles would make up around 75% of the market for cars. IC engine cars are utilised everywhere these days. But it has a lot of problems. For example, it operates on gasoline and diesel engines, which are old types of fuel, and it gives off a lot of carbon emissions, which are very bad for the environment. The price of fuels is going up because more people are using them. So, the easiest way to get over this problem is to use pure electric vehicles, which operate on batteries and don't make any kind of pollution. But the biggest problem with EVs is that they take a long time to charge and there aren't many places to charge them. In our project, we are trying to make things easy for the user by employing inductive coupling to make wireless charging work. There will be two plates: one on the automobile (the "receiving plate") and one on the ground. (transmitting plate). So that the user won't always have to connect the charger into the car. When he parks the car in the parking spot, the charging process will begin with roughly 97% efficiency and very little heat loss.

More and more electric vehicles are using the wireless option to charge their batteries. (EVs). Standard technique for wirelessly charging EV batteries is based on the Inductive Power Transfer (IPT) between two coils, one of which is linked to the power grid and the other to the rechargeable battery. The IPT is safer and more convenient since it doesn't need to be plugged in. With the IPT, the risk of electrocution from power cables is eliminated, and the battery charging process may begin immediately. There are two major forms of IPT for wireless charging, depending on how the EV is set up: static IPT, which is used while the vehicle is parked and no one is in it, and dynamic or quasi-dynamic IPT, which is used when the car is being driven. (e.g. while in motion or during the traffic red light). Dynamic charging can only be done by wireless power transmission, as a cable connection would be impossible when the device is moving. Even though Inductive Power Transfer has evident benefits, researchers need to work on a few things to make this technology even more appealing to the EV market. First of all, an IPT system is fundamentally less efficient at transferring power than a traditional wire-based system. In fact, the magnetic coupling between the coils makes it impossible to stop a little amount of magnetic field from leaking out, which wastes energy. Also, while putting an IPT system into practice, various technical details must be taken into mind. For example, to get the most coupling, the misalignment between the coils must be as little as feasible. As far as safety goes, even if the IPT can lower the chance of being electrocuted, you still need to be careful about being in a magnetic field. Aside from design difficulties, there are other significant things to think about, such as prices, effects on infrastructure, uniformity, and how customers will react.

The inductive connection may also be used to send electricity from the car to the grid, or the other way around. Vehicle-to-grid (V2G) is a common idea that is part of the modern idea of active demand. In a smart electrical network, the consumer can become an energy producer. The wireless power transfer can help V2G and is consequently a bi-directional inductive power transmission. (BDIPT).

2. TYPES OF WIRELESS CHARGING

There are mainly four types of wireless charging based on operating techniques

1.Cpacitive wireless charging sysytem

2.Permenant magnetic gear wireless charging system

3.Inductive wireless charging system

1. Capacitive wireless charging system: By changing the electric field, which causes displacement current, energy may be sent from the sender to the receiver without wires. Instead of magnets or coils, coupling capacitors are employed as the sender and receiver of power in this case. The AC voltage is initially sent to the power factor adjustment circuit. This is done to increase efficiency, keep voltage levels stable, and decrease losses while the power is being sent. Then, it's sent to an H-bridge, which makes a high-frequency AC voltage. This high-frequency AC is then sent to the transmitting plate, where it creates an oscillating electric field that, by electrostatic induction, moves the current at the receiving plate. By using rectifier and filter circuits, the AC voltage at the receiver side is changed to DC and sent to the battery through the BMS. The quantity of power communicated depends on the frequency, voltage, size of the coupling capacitors, and the amount of space between the transmitter and receiver. The frequency at which it works is between 100 and 600 KHz.

2. Permanant magnetic gear wireless charging system Here, both the transmitter and the receiver are made up of an armature winding and permanent magnets that are synchronised inside the winding. On the transmitter side, the functioning is like how a motor works. When we run AC current through the transmitter's coils, it generates a mechanical torque on the transmitter's magnet, which turns the magnet. Due to the change in magnetic interaction in the transmitter, the PM field on the receiver PM creates a torque, which makes the receiver PM rotate at the same speed as the transmitter magnet. Now, a change in the receiver's permanent magnetic field causes the winding to produce an alternating current (AC). In other words, the receiver operates as a generator because the mechanical power that goes into the receiver's permanent magnets is turned into electricity at the winding. Magnetic gear is a way to connect two spinning permanent magnets. After rectifying and filtering, the AC power that was generated at the receiver side was sent to the battery.

3. Inductive wireless charging system: Faraday's law of induction is the main idea of IWC. Here, electricity is sent without wires by generating a magnetic field

between the transmitter coil and the receiving coil. When the main AC supply is connected to the transmitter coil, a magnetic field is created that flows through the reception coil. This magnetic field moves electrons in the receiver coil, which provides AC power. The EV's energy storage system is charged by changing the direction of this AC output and filtering it. How much power is sent depends on the frequency, the mutual inductance, and the distance between the sender coil and the reception coil. The frequency at which IWC works is between 19 and 50 KHz.

3. PLUGGED IN CHARGING

There are so many chargers available for the charging of the EVs such as type 1, type 2, type 3 (based on the time required for charging).type 3 charger is the fastest among them all which required only 57 minutes to fully charged a EV of having battery capacity 40kw the charging having the rating of 50kwh so that we can see that there is a lot of energy loss in the charging and heat is also generated

Fig.1 Plugged in Charging of EV

Electric vehicles chargers are classified according to the speed with which they recharge an EV's battery. They are classified as follows:

i.Type 1

ii.Type 2

iii.Type 3 or DC fast charging

iType 1: In Type 1 EV charging uses a standard household (120v) outlet to plug into the electric vehicle and takes more than 10 hours to charge an EV for approximately 75-80 miles. Level 1 charging is typically done at home or at your work place. Level 1 charger have the capability to charge most EV's on the market.

ii.Type 2: Type 2 charging requires a specialized station which provides power at 240v. Level 2 chargers are typically found at workplace and public charging stations and will take about 4-10 hrs to charge a battery to 75-80 miles of range.

iii.Type 3: Type 3 charging is also called as DC fast charging. It is currently the fastest charging solution in the EV market. DC fast charging are found at dedicated EV charging stations and charge a battery up to 90 miles range approximately 1 hours

4. WIRELESS POWER TRANSMISSION USING INDUCTIVE COUPLING

Resonant inductive coupling or magnetic phase synchronous coupling[5][6] is a phenomenon with inductive coupling where the coupling becomes stronger when the "secondary" (load-bearing) side of the loosely coupled coil resonates.[6] A resonant transformer of this type is often used in analog circuitry as a bandpass filter. Resonant inductive coupling is also used in wireless power systems for portable computers, phones, and vehicles. WiTricity type magnetic resonance coupling systems add another set of resonant coils on the "primary" (power source) side which pair with the coils on the secondary (load bearing) side.

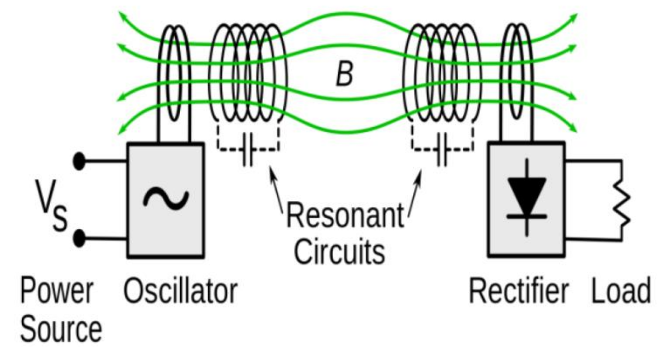

Fig.2 WPT using inductive coupling

Inductive coupling is the most basic type of wireless charging comparetively having more efficiency. Inductive Wireless Power Transfer (IWPT) Prototype Two circuits are built to implement a successful wireless power transfer prototyping. The transmitter circuit contains a DC power source like a PV panel in real life. In order to have a magnetic flux in the coil, the current must be converted to AC. To do this, an oscillator must be placed in the transmitter circuit. This causes the DC voltage to fluctuate rapidly, thus simulating an AC voltage through the coil. The oscillator used for this circuit is a basic LC oscillator with three components: a capacitor, inductor coil, and switch. For larger scale, an inverter could be used instead of the oscillator. In order to have a good and stable wireless power transfer, the inductors need to have a good quality factor. Before finding the quality factor, the resonant frequency must be determined.Once the resonant frequency is calculated, the quality factor of the inductor coils can be determined to see if the selected values of inductance, capacitance, and the resonant frequency are feasible for the circuit. A good quality factor for a typical wireless power transfer system needs to be at least 100 or above [84-88]. To determine the quality factor of the coils, The DC voltage, the DC current, and the DC power are calculated respectively. The transmitter and receiver coils are arguably the most important components of the wireless power transfer circuit. The coils have to be constructed with the proper inductance that will create a magnetic flux big enough for the secondary coil to receive. Another key factor in finding the mutual inductance is the coupling coefficient. The coupling coefficient can be between 0 and 1 with 0 being no mutual inductance and 1 being the best mutual inductance

5. WPT EFFECT ON BATTERY PERFORMANCE

In plugged in type of charging we are plug charger to the electric vehicle and then the charging gets started of the vehicle. Lithium ion battery is being used for the electric vehicles fordriving of the traction motor,

Fig.3 Actual Charging using inductive WPT

There are mainly water cooled system is used in the electric vehicles right now for the cooling of the battery which is not so suitable for the EVs because the weight increases and it also acquires more size. Another alternative of the cooling system is air cooled system, which is we are using in the IC (internal combustion) engines right now , but in EVs this technology is not efficiently working due to more heat is produced at the time of charging of the battery. When we use wireless technology for the charging very less amount of heat is produced comparatively.

6. MODEL OF INDUCTIVE COUPLING WPT

Two circuits are built to implement a successful wireless power transfer prototyping. The transmitter circuit contains a DC power source like a PV panel in real life. In order to have a magnetic flux in the coil, the current must be converted to AC. To do this, an oscillator must be placed in the transmitter circuit. This causes the DC voltage to fluctuate rapidly, thus simulating an AC voltage through the coil. The oscillator used for this circuit is a basic LC oscillator with three components: a capacitor, inductor coil, and switch. For larger scale, an inverter could be used instead of the oscillator. In order to have a good and stable wireless power transfer, the inductors need to have a good quality factor. Before finding the quality factor, the resonant frequency must be determined as shown in equation (1).

$$f = 1/2\pi\sqrt{(LC)} \qquad (1)$$

Once the resonant frequency is calculated, the quality factor of the inductor coils can be determined to see if the selected values of inductance, capacitance, and the resonant frequency are feasible for the circuit. A good quality factor for a typical wireless power transfer system needs to be at least 100 or above [84-88]. To determine the quality factor of the coils, the equation (2) is used.

$$Q = (\omega L/R) = (2\pi f\ L)/R \qquad (2)$$

The transmitter and receiver coils are arguably the most important components of the wireless power transfer circuit. The coils have to be constructed with the proper inductance that will create a magnetic flux big enough for the secondary coil to receive. Another key factor in finding the mutual inductance is the coupling coefficient. The coupling coefficient can be between 0 and 1 with 0 being no mutual inductance and 1 being the best mutual inductance. By applying the equation (3), the mutual inductance between the two coils can be calculated .

$$M = K \sqrt{(L1.L2)} \quad (3)$$

From above expression there are some points we have to be consider about the shape of the transmitting coils which we are going to use in WPT for the charging of the Electric vehicle

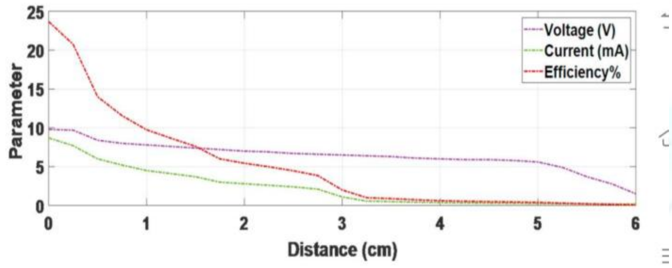

Fig.5 Voltage transferred, current and efficiency versus the distance in cm with Square plates

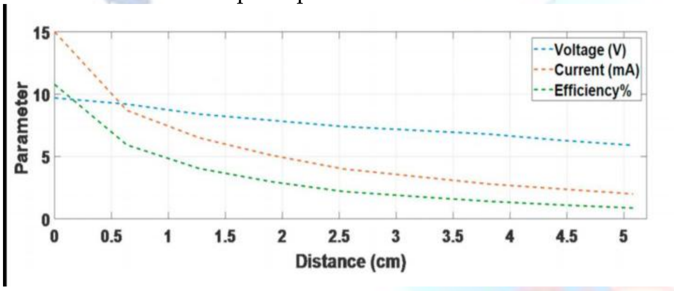

Fig.6 Voltage transferred, current and efficiency versus the distance in cm with round coils

From the above two waveforms, it's evident that square-shaped plates work considerably better than circular ones. Because of this, we think that square-shaped plates should be used for inductive coupling to charge electric vehicles. From the above graph, we can also see that the distance between the two plates is a crucial factor in their inductive coupling. As the distance grows, the efficiency drops, hence distance and efficiency are proportional to each other in the opposite way. The square coils have a quality factor of 100 or more, which means they may be used in a wireless power transmission system. So that the circuit works at the right frequency, it has to be tuned. Figures 5 and 6 illustrate examples of how the experimental measurements were made for both round and square coils. As the distance between the two coils gets bigger, the magnetic field between them gets less. In magnetic induction wireless power transmission, a current flows through the sending coil, which creates a changing magnetic field. This causes a current to flow in the receiving coil, which helps charge the electric car. How well it transfers power relies on how near the two coils are to each other.

7. Conclusion

When an electric car parks on top of a wireless charger, electricity is generated in the coil at the bottom of the car through a process called mutual induction. EVs can be charged wirelessly, so there's no need for cumbersome, lengthy cords to plug in. Low cost to keep up, yet expensive to buy. Better than the old-fashioned wired setup. With these Evs, the energy problem may be addressed.

In this study, a wireless power transmission and charging system was designed and tested with the help of analysis. We carefully made all of the models for each system, and in the end, we ran them all together. We can see that the highest efficiency of the system depends on the resonance and the distance between the coils in order to have the best power transfer between the input and output of the wireless charging system that was made.

Some problems still need to be solved, such building up the infrastructure and making energy use more efficient. Building the infrastructure for wireless charging under the road is a step forward for wireless charging and EVs that can charge while on the move. But wireless charging has so many advantages that it's just a matter of time until it becomes the most common way to charge an electric vehicle. In the future, everything in the planet will be wifi.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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