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A REVIEW ON ON-ROAD CHARGING OF ELECTRIC VEHICLES

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Abstract: The use and necessity of the electrical vehicles is drastically increasing in the world, The main problem in the electrical vehicles is charging. Here we have to look upon the upcoming technologies like on -road charging of the electrical vehicles. The vehicle will charge while it is in motion by wireless technology. we are looking upon the types of charging in dynamic power transformation between the two coils and design of the coils which is inside the road and vehicle. So many topologies are used for on-road charging system of EVs like Distributed WPT Topology and Lumped WPT Topology. Advantages of the dynamic charging methods is fast charging and time saving. Construction of the electrified roads by using transmitter coils and hot mix asphalt concrete are topology for construction. Installation of the receiving coil will be in the car which will receive charging. Asphalt mortar was used to construct the road surface to avoid damaging of transmitter coils by high temperature and high pressure during the vehicle is in motion.

1. Introduction

In recent years the use of electric vehicles is rapidly increasing, so many technologies are introduced to charge the electric vehicles. Among these technologies, a on road charging system can charge the EV batteries while the vehicles are in the motion. On road charging system is a unidirectional power transmission system. The car will get the power fromthe on-road power transmission system, which consists of the transmitting and receiving coils, are present in the vehicle and the road. Because of the continuous charging of batteries of the EVS, we will get the greater driving range while we travelling. The Time consummation is reduced by using the on-road charging system.

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Coming to the static charging system of EVS, we have to use big and bulky cables for charging of EVS. Cables are need to be physically connected to the Electric Vehicle for charging. At the time of connection of charger, may possible of sparking will occurs. In order to overcome the problems of the static charging system, we have to use the on-road charging system for charge the EVs. on road charging is the best conventional method for charging of EVS. The System which gives the more safety as compared to the any other charging system.

By using the dynamic charging system, we have to get more benefits like saving the time and getting the greater driving range. Economically the installation cost is very high but we get the long-term benefits form the on-road charging system.

1.2. Need of on road charging System:

In the entire world, the use of crude oil is increases in various sectors like Automobiles, industrial, power generation stations etc.…in order to the percentage of natural resource has been reduced. As researchers says that in year of 2100 where there is a huge crisis we have to face. The world is start look on the renewable sources like wind, water, solar. on the other hand, the transportation system has taken a grate changes example electric car

Electrical cars are the new era in the transportation system. And so popular in recent times. this is only happening because of the zero emissions of harmful gases.it is the ecofriendly less in cost, more reliable than the hybrid vehicles. The main problem in the electrical vehicles is the charging. Because of the battery capacity is verry low. initially the driving range is between 120 km to 150.And some battery management problems like optimization, thermal management age faced in the static charging system.A conventional mode of charging where physical connection of cables is eliminated is introduced. Wireless charging technology that has the potential to charge the vehicle in rest or in motion is introduced.

To reduce battery related problems, greenhouse gases and to resolving the magnetic field radiation problem the concept of Wireless Power Transfer (WPT) system is developed. It creates the problem for the Eves. The users want the long driving range,

in order to achieve the long driving range, we use big pack of batteries.as a result the weight of the vehicle is increases, by introducing the on-road charging system we replace the big pack of batteries with small batteries.

1.3. Issues and Solutions:

- Main issues in the on-road charging system is battery management system of the electrical vehicle.
- Thermal management of the battery.
- Conversion of the AC to DC power.
- Charge time.
- Lack of charging stations.
- Installation of the transmitting coils under the road.

The best solution is to over these problems we use the on-road charging system. This help to reduce the time taken to charge the electrical vehicles. And provides greater driving range. On road charging system is the latest technology to charge the EVs. Having the lot of scops to research.

2.CHARGING TECHNIQUES INVOLVED ON ROAD CHARGING OF EV'S:

There are mainly two types charging method involved in order to charging EVs.

- Method of Static charging
- Method of dynamic charging

2.1. Static charging system:

In static charging system the power is transfer from the transmitting coil to the receiving coil, through the medium of air.The system is works on the principle of faradays law of electromagnetic induction, i.e., the receiving coil cuts the magnetic field by the transmitting coil, as a result the EMF is induced in the receiving coil which is further stored in the battery.But the system has some disadvantages like:

- We need to park the vehicles long time in the charging stations
- The charging system needs a separate area
- Problems occurs during plug-in and plug-out (some chances to occurs the sparking during the connection of the charger.

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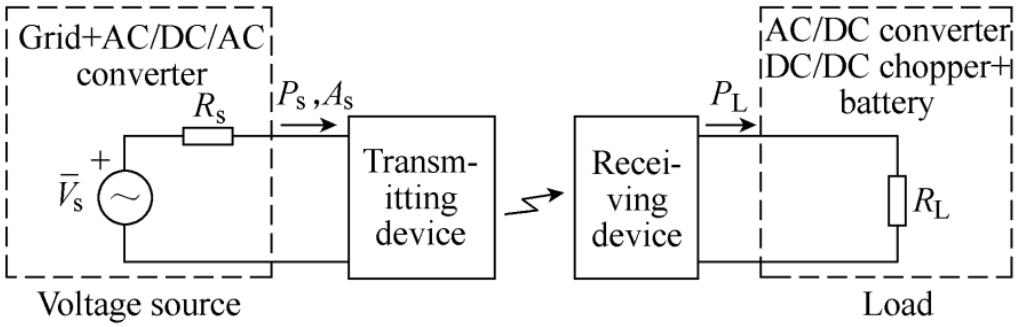

Fig-1: Block diagram for static charging system

The volage source getting power from the near Grid, which is converts AC/DC/AC by using converter, the power which further supplied to the transmitting coils. as a result, magnetic flux will be produced. In order to induced the EMF, the receiving coils must cut the magnetic flux. The induced emf will be stored in the batteries by the help of the AC/DC converters (or) DC/DC choppers. The power which is stored in the batteries. which gives to the motors to dives the total power train.

2.2. Dynamic charging system:

Dynamic wireless power transfer (DWPT) systems charge while vehicles are on the move. Hence, DWPT provides energy to the battery and increases the driving range, and decrease the battery size in EVs. It requires specified charging lanes on the road so that the vehicles can be charged while travelling in specified charging lane. The system which works on the principle of faradays law of electromagnetic induction. The vehicle getting charged by the coils which is magnetically connected. In the dynamic charging system, the converters play a major role because of the coupling period is very small.so the emf which is induced in the receiving coil is very less. We need work on the high voltage to charge the vehicle, which decreases the time taking to charge the vehicle.

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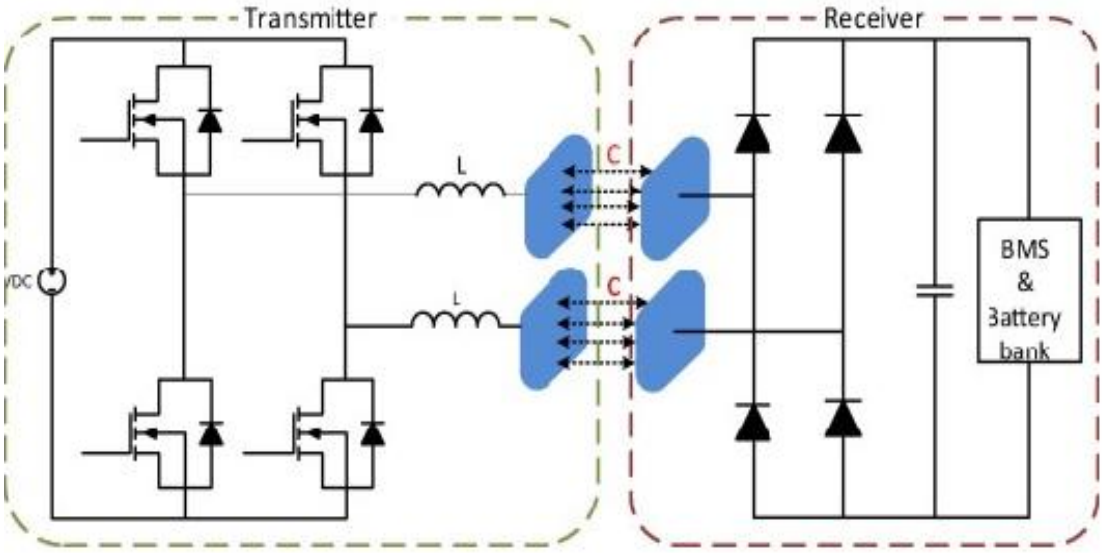

Fig-2: Block diagram for dynamic charging system

The transmitter which is connected to the nearby grid to the getting power, the AC or DC voltage is given to the converters, which is connected to the transmitting coils. The coils are creating the flux, the receiving coils which is installed in the bottom of the vehicle. The coils are cut flux in order to induces the emf. the coils are connected to rectifiers which converts AC to DC. The DC voltage stored in the battery which is used for the vehicle movement.

3.MECHANISM INVOLVED IN CHARGING OF EV's:

3.1Coupling coefficient:

The on-road charging system is mainly working on the principal of faraday electromagnetic induction. whenever the conductor cuts the magnetic flux which is produced by the transmitting coil, the induced EMF will producein the receiving coil. Dynamic charging system is involved in the concept of on road charging system. i.e, the vehicle is getting charged during the vehicle is in the movement.

The power which Is transfer from transmitting coil to the receiving coil, here the coupling co-efficient plays a important role. When the receiver coil is positioned above the transmitter coil at a height h, the coupling coefficient "k" between the coils is proportional to the ratio of the overlapped area of the coils to the area of the

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transmitter coil and inversely proportional to the third power of the distance between the coils. For calculating the coupling co efficient of the coils is we have a equation is

$$\kappa = \frac{2R}{a} \cdot \left(\frac{R}{\sqrt{b^2 + 4h^2}} \right)^3 \quad \text{.....(1)}$$

Where the k = coupling co-efficient

R= radius of the transmitting coil.

a= length of the conductor which is used in transmitting coil.

b=breadth of the transmitting panel.

h= height of the transmitting panel.

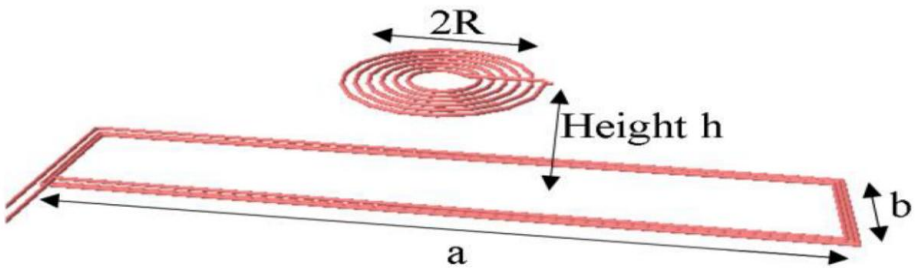

Fig-3: Schematic showing the receiver coil positioned above the transmitter coil

This is the process to find out the coupling coefficient of the coils. The coupling co-efficient is proportional to power delivering to the receiving coil. The coefficient is mainly depending on the conductor length and radius of the coil.the coupling coefficient "decreases with a longer a transmitter coil. the coupling coefficient κ increases with the radius of the transmitter coil. A smaller "k" results in lower power transfer efficiency and also smaller transferable power of the system.

The transfer efficiency is mainly depending on the positioning of the transmitting and receiving coils. The efficiency will vary by the different positions of the coils.

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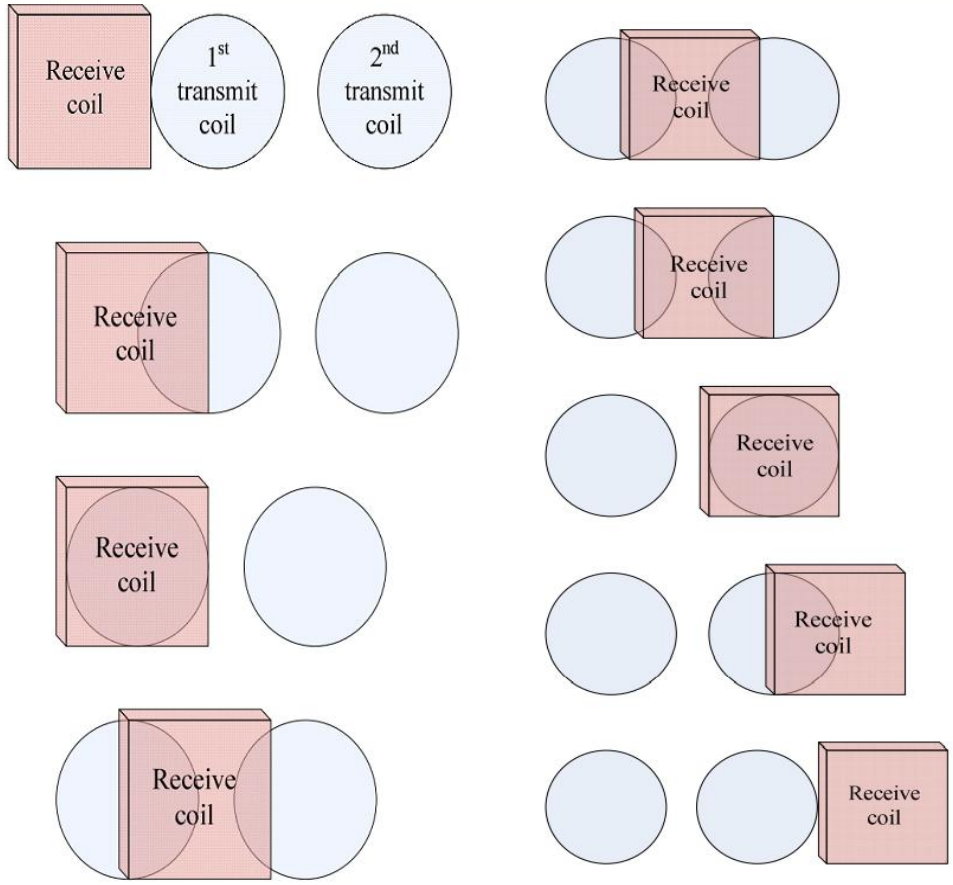

Fig-4:. Incremental secondary pad positions with respect to primary pads.

Position 1) Right before alignment with the first transmit coil; edge to edge, Position 2) 50% aligned with the first transmit coil, Position 3) Perfectly aligned with the first transmit coil, Position 4) 50% misaligned with the first transmit coil, towards the second transmit coil, Position 5) Right in between two transmit coils, Position 6) 50% aligned with the second transmit coil, Position 7)Perfectly aligned with the second transmit coil, Position 8) 50% misaligned with the second transmit coil, and Position 9) Right after alignment with the second transmit coil; edge to edge. These are the some positionings of the transmitting and receiving coils. the power transmitting will be depending on the area which is covered by the both transmitting and receiving coils. the maximum power is transmitted when the receiving coil is placed at correct alignment with the transmitting coil. The 2^{nd} and 7^{th} coil alignment gives the maximum transfer efficiency.

in order to understand the more deeply we look upon the block diagram of the on-road charging system of the electric vehicle. In the on-road charging system converters are

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plays a important role. We take the power from nearby grid and gives to the charging station. the charging station is initially employed to the lot of required converters, the incoming voltage is generally a AC voltage, the AC to converted variable AC frequency and its converts DC voltage it is totally depends in the user requirement.

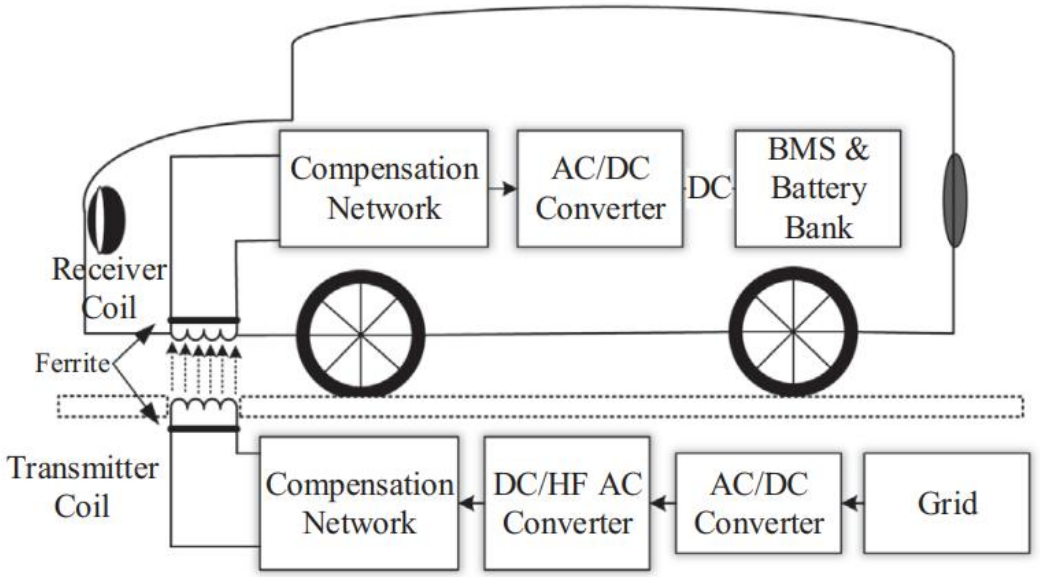

Fig-5: Block diagram for total power train dynamic charging system

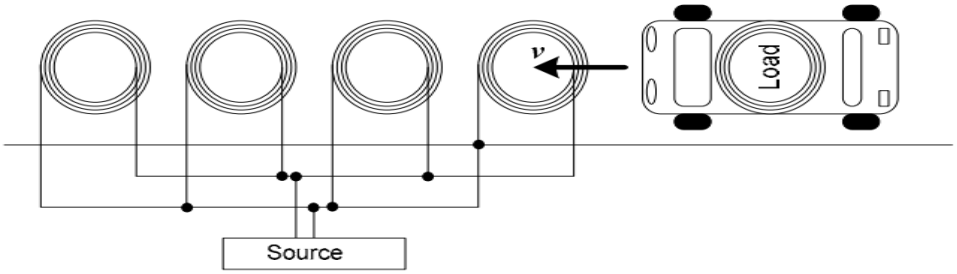

Fig-6: Vehicle movement on transmitting coils

The converter converters the AC to DC, or AC to variable high frequency AC. with is further given to the compensation network which consists of the power electronics and transmitting coil. The transmitting coils transmit the power to the receiving coil by the principle of the faradays law of the electromagnetic induction. the receiving coil cuts the magnetic flied and build-up the emf. the compensation network which is directly connected to the AC/DC converter. the converter is used to converts the variable AC to DC or pulsating DC to fixed DC. The DC voltage is given to the

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BMS& battery pack, the battery management system is supplying the power to various parts in the entire power train.

3.2 Road construction:

The road construction is major challenging factor in the whole scenario, because of the construction has required more investment, and taking more care during the installation the transmitting coils under the road. In order to construct the road some precaution need to take.

The high-grade concrete and steel are used in the contraction of the roads. They give the long life to the road is returns the more profits to investors.in Order to having the strength to the transmitting panels we use the cement asphalt mortar (CAM).Cement asphalt mortar is an organic-inorganic material composed of cement, asphalt emulsion mortar, fine aggregate, and other chemical components. The advantage of the asphalt cement is thermal management. It is controlling the temperature of the panel and keeps more efficient and gives the long life to the transmitting coil.

Fig-7: Photograph showing the paving of the test road

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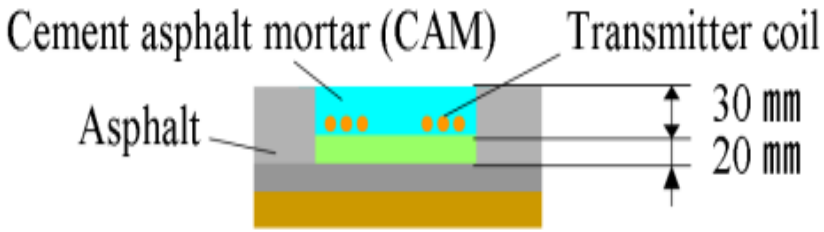

Fig-8: Schematic cross-sectional view of the test road

During construction of the road, the installation depth id about 50 mm to 120 mm , as the asphalt cement is poor besides the transmitting coils, its gives the strength to the coil.

The installation is done by the various blocks. Each consisting of the one transmitting panel.

4. SAFETY CONSIDERATIONS FOR DYNAMIC CHARGING:

In the dynamic charging system have many advantages. In order to get the advantages from the on-road charging system we need to follow some safety masseurs like

- Electromagnetic field Exposure
- Fire Hazards

4.1 Electromagnetic field Exposure:

Electromagnetic field exposure is major concern for dynamic charging system. In some times its serious damages to human life. There are 2 types of exposures excites.

4.1.1 Low-frequency electric fields:

It influences the human body just as they influence any other material made up of charged particles. When electric fields act on conductive materials, they influence the distribution of electric charges at their surface. They cause current to flow through the body to the ground.

Low-frequency magnetic fields induce circulating currents within the human body. The strength of these currents depends on the intensity of the outside magnetic field. If sufficiently large, these currents could cause stimulation of nerves and muscles or affect other biological processes.

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4.1.2 Radiation hazard:

Mainly, the most hazardous radiation zone is right between the two coils, and secondary hazardous zone is around the coil. These areas are the most hazardous zones but it is noted that they are not directly exposed to humans or animals at all time. Comparing with these areas, another important hazardous zone in need of consideration is near the charger and around the car (not under the car), and it exposes to the general public directly. This area along with the two hazardous areas under the car needs to be considered during the design cycle.

4.2 Fire hazards:

All the power electronic devise are made with low thermal abilities, in case of any high temperatures are produced by the either battery and any other devices. They're having some scope to occurrence of fire accidents. In order overcome the problems we need to follow some safety masseurs. Like insulation of the wires and well battery management system (BMS). Safety and performance standards for wireless charging for EVs are currently under development. The automotive industry and other organizations are developing the technology

and improving it not only from a performance perspective.Due to the large area of electromagnetic field exposure between the car and the primary coil and high electrical power involved in this application, the product or system needs to be designed accordingly in order to meet the safety standard.

The organizations are made attention to the users and customers to providing the well safety precautions in the vehicle to attract. It has more scope to research and developments.

CONCLUSION:

This paper has presented the design and evaluation of a wireless power transfer system with road embedded transmitter coils for dynamic charging of an EVs. In this paper we come across methods of charging of a electric vehicle, block diagrams for energy conversion. the construction of the road using cement asphalt mortar. And the installation of the transmitting panels.

The major technology that has higher efficiency i.e., coupled co-efficient discussed. In paper majorly we look upon the safety factors faced during the on-road charging system. The transfer efficiency is mainly depending on the position or area occupied by the transmitting coil and the receiving coil. We look up the various position scenarios for the vehicle movement.

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