

# PROBLEMS IN ELECTRIC VEHICLES

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**Abstract:** - Electric vehicles are the transportation machines which uses electric energy as power source for movement. The objective of this technical journal is to propose an idea to solve the electric automobile problems which are causing the backlog for sales and demand of electric automobiles in the Indian market. This is a technical journal consisting of a case study of electric vehicle problems in India, applications and advantages of electric vehicles, simple analysis of problems one by one based on common thinking abilities, disadvantages in electric vehicles, discussion of preferable solutions for the electric vehicle problems and its disadvantages, field survey, listing the situation in order systematically, different types of batteries that can be used, motors that can be preferred for electric automobiles, preferred solution discussion including result discussion with an example of electric automobile and finally conclusions. We have discussed on batteries and motors that are suitable for electric vehicles. We have tried to solve the problems of electric vehicles after listing the problems that can be faced in electric vehicles one by one. The main concept of this paper is having the battery exchange stations to exchange the charge dried batteries to fully charged batteries. In battery exchange stations, a customer using electric vehicles should pay some amount and can exchange his used batteries to fully charged batteries. We have discussed the way of working of battery exchange stations. Hydrogen fuel cell concepts are also detailed in this paper.

**Keywords:** - Sales of electric vehicles; Case Study; Battery exchange stations; Charge dried; fully charged; Fuel Cells.

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## I. INTRODUCTION:

You may wonder 'why the electric vehicles must be preferred rather than the Internal Combustion Engine Automobiles'. If so here are some reasons below to prefer Electric Automobiles in India: -

- As you know electric vehicles don't emit smoke so it is environment friendly.
- Electricity is more than 10 times cheaper than fossil fuels for same power extraction in India because of the hydro-power, wind power, solar power, that is in general renewable power extractions in India is huge and India is also developing its capacity of extraction.
- Maintenance cost will be negligible when compared to IC Engine vehicles.
- In our country there are no big fossil fuel sources, so we have to import petroleum oils in large scale continuously.
- As we know scientific research says all the fossil fuels will be exhausted by 35-40 years.
- India will lose the petroleum supply even much earlier because all the countries will decide some or the other day to preserve the petroleum for their future usage before it is exhausted completely.
- As everyone knows in whole world, petrol prices are highest in India itself.
- If war is declared against Islamic Nations for any reason then supply of petroleum will be stopped and most important fact is that maximum petroleum produces is in Islamic nations only.

If the petroleum is not imported to India from other countries or if other countries stop supplying petroleum to India then our country will stand still suddenly. There will be no transportation of any kind and we know all the causalities that will happen to India if the above statements come true. So to be prepared for the above scenario that we come to reality in future for sure, we have to think of any other means of transportation which will not use petroleum products as main source of fuel. In my opinion electricity is the only power that can replace petrol and diesel since bio-products such as bio-gas, ethanol, methanol, bio-diesel, bio-fuels from eucalyptus oil etc., cannot be mass produced on a scale which will satisfy transportation of 1.3 billion people in India. Bio-fuels production time including growing of raw materials is too high and it is very small scaled for fast growing transportation power requirement problems in India. So, electricity or even hybrids such as electricity with bio-fuels, electricity with human power for 2-wheelers, electricity with petroleum fuels etc., can solve the problems of road transportation in India in future. This technical paper deals on solving the electric automobile problems that we are facing now in India by giving some ideas which help in the beginning of the evolution of electric vehicles usage.

Since we know that in future electricity will be the main source of fuel for road transportation, we have to solve the problems in electric vehicles.

The main problems that the electric vehicles are facing as per my vision are listed below: -

- Batteries are too costly.
- Batteries should be replaced when its life is over.

- Frequent recharging is a very important drawback.
- Recharging time is high and waiting for recharging is a big pain.
- Access for recharge is not easily available outside the home, but in the case of petrol and diesel availability, it is not a problem.

All these problems are directly related to power supply system (that is batteries). So, problems can be solved if we work on batteries of different types. Also no other problems will be faced in electric vehicles by customers. Just to notify acceleration in electric automobiles are great, no problem with acceleration and speed of the vehicle because how much ever speed and acceleration is required, can be obtained by increasing the power of the motor. Thus solving the above listed problems can do miracles and electric vehicle sales can touch the sky very fast by eliminating conventional petrol and diesel engine automobile sales on the way rapidly.

## II. SCARCITY OF ELECTRICITY:

‘Does electricity production in India can satisfy power for transportation?’ this is the question we get when we think of electric vehicles usage in large scale. Our answer to this question is yes, of-course we can satisfy the electric power needs even if the transportation is completely dependent on electricity. The ways to satisfy the electric power needs including transportation is discussed below.

Bio-fuels can be used to produce electricity in future in quiet a large scale like bio-fuel thermal power plants in Tumkur district at Kabbigere village called ‘Hasiru Shakthi’ wherein they dry eucalyptus trees and heat it in absence of air that is in absence of oxygen to high temperatures or burning eucalyptus trees in very less supply of oxygen. This process is called pulverization and this produces carbon mono oxide and hydrogen mainly. These two main outputs are having high calorific values. High calorific values of carbon mono oxide and hydrogen makes them eligible to be burnt in compression ignition engines to extract mechanical work from it. Eucalyptus oil can also be extracted from eucalyptus trees, burning this eucalyptus oil in gas format in the compression ignition engine generate electricity through mechanical work production. There are many other different trees and plants that can produce bio-products like sunflower, rice straws, rice husk, wheat byproducts, groundnut oils, neem trees etc., There will be many other different ways to get the power and supply to the whole country. Renewable power sources like solar energy, wind energy, bio-fuels energy, tidal energy, hydro energy, nuclear energy etc., and non-renewable power sources like coal, wood etc., are hugely available in India to take care of the electricity production in future but we have to

work on extracting them efficiently. If this happens as predicted then there will be enough power to supply for the transportation also. Thus, these discussions prove that there will be no scarcity for electric power in the future, and also for road transportation in India.

## III. OUR VISION OF SOLUTION FOR THE PROBLEMS:

There is one single solution that will solve all the problems listed above to help electric automobile sales. The solution is choosing and using the batteries which has a high energy density (high VA) thus increasing the range of electric vehicles and exchanging the batteries after usage in the battery stations to the fully charged batteries (like petrol bunks presently).

In other words ‘we have to just use the electric vehicle until its charge is over and go to nearby battery station and exchange the charge dried batteries to fully charged batteries which takes just a few seconds and go on riding it. This method of fuelling will take less time than filling the petrol or diesel for the same range compared to electric vehicles. This battery stations concept is coming into existence in few countries abroad but with unsolved problems and unanswered questions like batteries that should be preferred by all, success of the idea etc., because every country has its own mentality and different people who thinks in ‘n’ number of ways as per the country financial support and peoples’ financial situations.

### Consider all the disadvantages or main problems that are listed above one by one.

- **Batteries are too costly:** - This will be not a problem because batteries will be continuously exchanged with the battery stations by electric vehicle users. So the replacement headache is for battery stations, they have to estimate the battery life and their replacement cost after their life and collect it at every battery exchange time from the customers on the prorata basis by calculating the replacement cost of the dead batteries to new batteries.

Battery stations should charge the customers (every time when they come to exchange the batteries) for recharging batteries, small calculated amount for replacing of the batteries after their life and their fixed profit margin. The best way is to collect the cost for replacements of the batteries after its life while purchasing the electric vehicles itself. The cost should be collected less considering the interest of the amount paid at start. This will be like an

insurance policy which is a single payment but lifetime membership.

- **Batteries should be replaced when its life is over:** - This also will not be a problem for the electric automobile users because the battery stations will take care of the replacement of the batteries.
- **Frequent recharging:** - We don't need to recharge the batteries; we just have to exchange the batteries with battery stations. So, this problem is also solved.
- **Recharging time required:** - Since we have to exchange the batteries and don't have to recharge the batteries and also the exchanging time is very fast; so, we can also overcome this disadvantage.
- **Access for the recharging:** - Because we don't need to recharge the batteries; we have to exchange it in battery stations; accessibility depends on number of battery stations present like fueling stations of petrol and diesel.

Now we can conclude that all the problems faced by electric automobiles will be solved now if we follow this method to power the electric vehicles. Thus we can increase the sales of the electric vehicle suppressing the sales of the petrol and diesel automobiles. Finally one fine day we can eliminate all IC engine vehicles totally. This battery stations can be brought to existence if the range and life of the batteries chosen to be used in electric vehicles is considerably good. The different types of batteries that can be chosen for usage in electric automobiles are discussed below one by one.

#### IV. DIFFERENT TYPES OF BATTERIES:

Batteries are the current storing devices. The different types of Batteries that can be used are listed below:

- **Lead acid Batteries**
- **Li-ion Batteries**
- **Carbon-Zinc Batteries**
- **Alkaline Batteries**
- **Ni-ion Batteries**

All batteries should be compared with each other to judge the best battery for recharge free electric vehicles.

*These figures given below in tabular column help in choosing which battery type is best for a given application:*

The energy/weight ratio, the energy/volume ratio, the power to weight ratio, and the cost in watt-hours per dollar are some of the parameters we can

consider for choosing the batteries for our recharge free electric automobiles. These parameters are tabulated below in comparison to the common lead-acid battery which is probably the least desirable to run an electric vehicle.

**TABLE: - 1**

Battery Type	Cost(\$)/power	Watt-hour/kg	Joules/kg	Watt-hour/L
Lead-acid	\$0.17	41	146,000	100
Alkaline	\$0.19	110	400,000	320
Carbon-zinc	\$0.31	36	130,000	92
Ni-ion	\$0.99	95	340,000	250
Lithium-ion	\$0.47	128	460,000	230

As you can clearly see choosing Carbon-Zinc batteries or Ni-ion batteries is not desirable at all because of its high cost and low power storing capability for the rates of the batteries. So, we can't choose these batteries for our recharge free electric vehicles. Thus, we haven't discussed about these two batteries in our paper.

#### ➤ **Lead acid Batteries:**

These are the commonly used batteries in electric vehicles in present days. These batteries have low power density and thus they don't suit for using in recharge free electric vehicles generally. Lead acid is the power storing substance in lead acid batteries. But, they have the advantage of economy i.e., they are very cheap when compared to the Li-ion batteries. So we can just use it for those vehicles which have less weight and short range is sufficient like 2-wheelers. If the weight is more or if range required is more then we have to use more lead acid batteries or we have to increase the size of the batteries. This causes very much difficulty while exchanging the batteries in battery stations and also this increases the weight of the vehicles.

Thus, we can use lead acid batteries only in low weight and small ranged recharge free electric vehicles because of their low power density. Even though Lead acid batteries are very cheap they have very small life when compared to Li-ion batteries. So, not using them is preferable when initial vehicle cost is not much of concern. Even though Lead acid batteries have low energy storing of 146 Joules/Kg, it is very less in cost. So, Lead acid batteries are preferable only for its less cost in electric vehicles.

#### ➤ **Li-Ion Batteries:**

Lithium ion batteries also called Li-ion batteries have high power density when compared to lead acid batteries. These batteries are generally used in mobiles and laptop because of its low weight and high energy storage density. Li-ion batteries have nearly 3 times more power storing density for same

size and weight as that of lead acid batteries. So, few electric cars are using Li-ion batteries to store the electricity required. But Li-ion batteries are very costly and expensive. To compensate this disadvantage we have an advantage of battery life. Li-ion batteries have very long battery life of around 15 years or so. Thus we can afford and decide to use the Li-ion batteries in recharge free electric automobiles also. Even though Li-ion Batteries is very expensive, it has a very high energy storing capacity that is 460 Joules/Kg. So, Li-ion Batteries is most preferable if the initial investment is not much of concern.



Figure 1: - Lead acid

Figure 2: - Li-ion

### ➤ Alkaline Batteries:

As per the above table, you can clearly observe that the alkaline batteries have very high energy storing capacity of 400 Joules/Kg and they are very cheap in cost also. But alkaline batteries cannot be recharged by common man easily. We can recharge the alkaline batteries but it's too difficult, we need suitable charges for recharging. Usage, properties and recharging of alkaline batteries is discussed below briefly.

Alkaline batteries have long shelf lives that are they do not discharge themselves even though they have kept used for long time. Alkaline batteries do not suffer the 'memory effects' like Ni-ion batteries suffer. The term 'Memory effects' refers to the batteries becoming weaker with continues usage. Generally alkaline batteries cannot be recharged; to recharge an ordinary alkaline battery we need a right type of equipment to do the job.

The question arising will be 'How many times an ordinary alkaline battery can be recharged?' Would you believe, the answer is hundreds of times? The trick is to stop using the batteries well before it has given up all of its available stored energy because if the higher current is drawn draining the batteries or if the batteries had been completely discharged then the whole active area of the anode will involve thus

making the reaction irreversible which produce current. So, batteries should be recharged before it drains out complete charge. For this reason, the recharge free electric vehicles should have the cut-off voltage and below which the vehicle should not run. Therefore fixing the cut-off voltage will solve the problem in alkaline batteries to be used in recharge free electric vehicles and alkaline batteries will return to battery stations before the charge is completely empty. Battery stations can recharge the alkaline batteries safely using right equipment that is by using right chargers like **Battery Xtender™**.

When the drill stops turning, charge the battery, but not before is a good rule for Ni-ion batteries, but not for alkaline batteries. To safely charge alkaline batteries using suitable chargers like **Battery Xtender™** charger, don't wait for the battery to stop working and charge it before itself by fixing a cut-off voltage. When voltage drops to cut-off voltage, charge the batteries.

### Chemical reaction in alkaline batteries:

In an alkaline battery, the anode (negative terminal) is made of zinc powder, which gives more surface area for increased current, and the cathode (positive terminal) is composed of manganese dioxide.

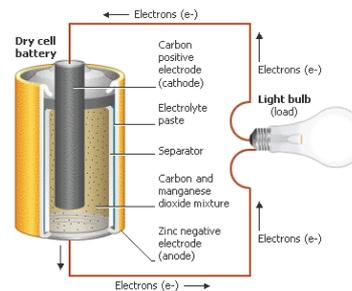
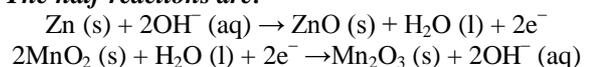


FIGURE 3: - (Sectional view of alkaline batteries)

### The half-reactions are: -



Alkaline batteries don't work good if the load is more. So, alkaline batteries will not be efficient if the power extraction from it is not more than 1.5V. All alkaline batteries are made for 1.5V application only to get best efficiency. But to counter this problem and overcome it alkaline batteries can be connected in parallel to one another and higher voltage can be obtained from the set of alkaline batteries with same very good high efficiency. Thus, many big and long rod type alkaline batteries should be connected in parallel in box to make a suitable big battery for the recharge free electric vehicles. We can also connect these types of alkaline battery boxes in series to obtain more current storage capacity for our recharge free electric vehicles. This big battery box having many alkaline batteries connected in parallel

and fixed should be replaced wholly in battery stations for recharged ones. Battery stations will charge the alkaline batteries with suitable chargers one by one.

So, alkaline batteries assisting with the cut-off voltage vehicle stopper is very much suitable and best preferred batteries for recharge free electric vehicles because of its cheap cost and very high energy storing capability. Most important thing that should be noticed is that the world's fast electric vehicle used alkaline batteries to power itself.

## V. MOTORS & DIFFERENT TYPES OF MOTORS:

Motors are the machines which converts electrical power to mechanical rotary motion. There are many types of motors that we can prefer for our recharge free electric vehicle. But, we need a type of motor which has high torque even in less speed or less RPM. So, the list of preferable motors boils down to two types.

The two types of preferable motors for are:

- Direct Current Series Motors
- Alternative Current 3 Phase Induction Motors

Direct Current Series Motors or in short DC series motors are the best motors for the locomotives and automobiles because of its very high torque at low RPM. In fact they say DC series motors should be started without a load applied to it. DC series motors have the property of high torque at low RPM & as RPM increases, Torque decreases. So, torque variation with respect to RPM present in this type of motors is best suitable for driving the automobiles.

Alternative Current 3 Phase Induction Motors are also preferable motors for the electric vehicles. The most famous and most selling electric car in India that is REVA (now MAHINDA REVA) uses AC 3 Phase Induction motors. These motors have very high efficiency and have all properties required for electric cars. So, AC 3 phase induction motors are also an option for our recharge free electric vehicles.

Motors used in electric vehicles will be generally brushless motors because to ease out the design complication and to reduce weight of the vehicle by reducing the components. Generally both the type of motors will be Hub motors (motors which are mounted in the wheel of the vehicle itself) to reduce the transmission loss and to reduce the weight of the transmission systems. These Hub motor and brushless motor concepts can be included in the recharge free electric vehicles we have been discussing all these time. After deciding the type of motors, we should concentrate on the power required for the electric vehicle and choose the motors.

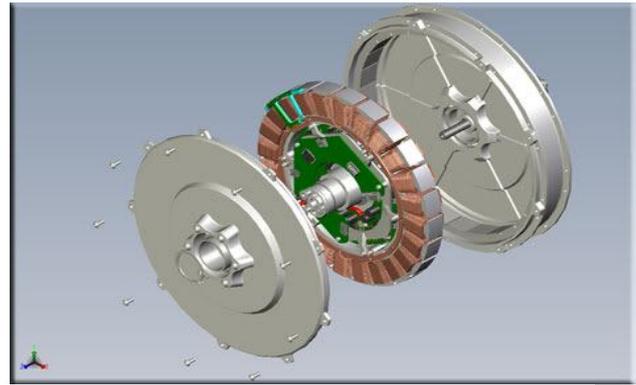


Figure 4: - Brushless, Hub motor Sectional View

## VI. RECYCLING OF BATTERIES:

If recharge free electric vehicles come into existence then the recycling of the batteries is the head ache of battery stations. Battery stations should recycle the batteries after its life. It's better to send the batteries to the respective companies for replacement and those companies should charge all battery stations equally because battery stations which receive the dead batteries should not face any losses. The other option is giving the franchise or agencies for opening the battery stations by the battery company itself so no problems like exchange the new battery for dead battery and facing the losses for the same. This type of system will be like a domestic cooking gas supply systems in India.

We can reuse after processing the many materials in batteries like potassium in alkaline batteries, magnesium, zinc, lithium etc. Even the battery case (which may be plastic or metal) can also be recycled and reused. All batteries can be recycled including lead acid batteries, Lithium-ion batteries and alkaline batteries. Recycling of all the materials in batteries will reduce the money for making the new batteries and also save the environment because we don't dispose maximum materials (which is non-biodegradable material and hazardous to the environment). Recycling of batteries will also reduce the working cost of the recharge free electric vehicles for customers. So, recycling of batteries is also an essential part of the working.

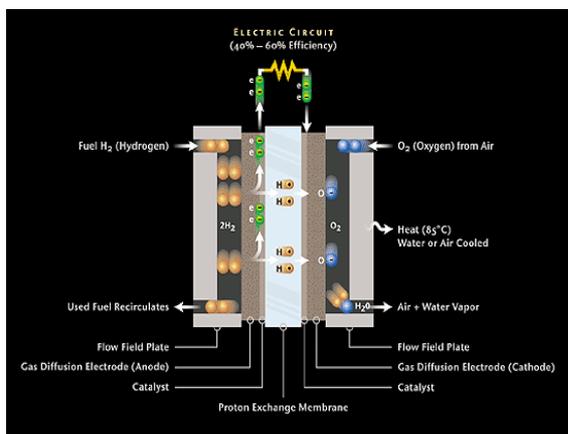
## VII. HYDROGEN FUEL CELLS:

We can power the motors using hydrogen fuel cells also. We don't need batteries if we use this. Hydrogen fuel cells work on pure hydrogen. In hydrogen fuel cells, the H-H bonds exist. Hydrogen will be in liquid state and they will be tending to react with the oxygen in the atmosphere. But the only way out for the hydrogen from the fuel cell is through the mesh like structure made up of an anode, a cathode, catalysts and a proton exchange membrane as shown in the figure below. This mesh structure is so fine that

hydrogen-hydrogen bonded molecules cannot pass through it. So, the hydrogen molecules split and protons of hydrogen will pass through the mesh (proton exchange membrane) and come to other side of the mesh. Even the electron can't pass through the mesh because of the electromagnetic field present around the electrons. Thus, electrons will come across the mesh through wired circuit passing all the resistances and loads. Thus current will be extracted. Once the electrons reach the other side of the mesh after loading and working all the components connected in the circuit, it combines with the protons and reacts with oxygen in the atmosphere forming the water molecules ( $H_2O$ ). Formed water vapors will escape to atmosphere. This is how the hydrogen fuel cells work.

We can use the hydrogen fuel cell also for the recharge free electric vehicles. Just we need to fill the liquid hydrogen in the battery stations or fuelling station and continue to drive. This will be much easier. But the only problem is that production of hydrogen is very difficult and expensive. We can produce hydrogen from water by electrolysis but we get only 2% efficiency in splitting the hydrogen from water and remaining 98% of power supplied will go as waste. Hydrogen can be produced from methane but this is also expensive. So, scientists are working for cheap, efficient and better way for producing hydrogen. If scientists become successful in producing hydrogen in efficient and cost cheap way then this hydrogen fuel cell powered electric vehicles will be a best option. But as per now using batteries is the only solution for electric automobiles power supply in India.

The working of the hydrogen fuel cell is explained above in previous paragraphs and the pictorial representation of the working of the hydrogen fuel cells is shown below.



**Figure 5: - Working of Hydrogen fuel cell pictorial representation**



**Figure 6: - Electric Car with 8 wheels, Li-ion batteries 8 Hub brushless DC Series Motors (one in each wheel).**

This car has a top speed of 370 KMPH and a range of 200 KM. This car has front four wheel steering system. Car shown above proves that electric vehicles are also capable of competing with the IC engine cars in all matters like good speed, acceleration, comfort and having a good range.

## VIII. RESULT AND DISCUSSION:

We can bring the recharge free electric vehicles into existence. But for cars, exchanging the very huge batteries in battery stations for small ranges like 100 to 120 KM is not desirable. ***The range must be good and there must be an option of self charging the batteries by plug-in to current supply for all recharge free electric vehicles.*** To get the better range for electric vehicles we should prefer for Li-ion batteries or alkaline batteries only rather than the Lead acid batteries. The range of the electric cars running in Li-ion batteries and alkaline batteries with comparison to lead acid batteries will be very huge. Li-ion batteries and also alkaline batteries can store more than 3 times the electric charge that can be stored in lead acid batteries. This charge storing capability of all the batteries can be observed in the **Table: - 1** given above.

Since the charge storing capability of the batteries (current supply or current delivered) is directly proportional to the range of the electric vehicle when the load, resistance, power of the motor and motor RPM remains constant "We can clearly state that electric car will have a range of 350-360 KM per full charge of the batteries if we use Li-ion Batteries or Alkaline Batteries instead of lead acid batteries of same weight otherwise the car would have a range of 110-120 KM per full charge of batteries in lead acid batteries." For example a MAHINDA REVA famous electric car in India is having a range of 120 KM per full charge and it runs on lead acid batteries. If we replace the lead acid batteries with Li-ion batteries or alkaline batteries, we can get a range of nearly 360 KM or more for the

same power of motor and same battery weight. Even the battery life will be more for Li-ion batteries than the lead acid batteries. Life span of lead acid batteries will be approximately 3 years and life span of Li-ion batteries will be approximately 15 years (that is 5 times more life). An electric car having a range of 360 KM is very decent and respectable range.

## IX. CONCLUSION:

Recharge free electric vehicles are also a better option for the alternative way of road transportation in India. Survey states that India has the highest petrol price in whole world, so as of now Indians should concentrate for alternative sources of power for road transportation and implement it as soon as possible. Recharge free electric vehicles concept will run successfully like domestic gas companies and its agencies in India. Electric vehicles in India are booming up and in future electric vehicle or hybrid vehicles with electricity as option will take over in India. Switch over to electric vehicles will be the best solution for all the people in India because of continues increasing prices of petrol and diesel.

We can start the electric vehicles era by simple steps like buying the electric vehicles, telling or advising others to buy electric vehicles by telling them the advantages of it. Not only the environment will be saved but also the economy of this country will improve for sure because the major import product for India is petroleum. If the electric vehicles are used largely in city limits then the pollution will drastically come down reducing health problems. Conclusion of this paper is electric vehicles in systematic way of recharge will dominate the Internal Combustion Engines (IC Engines) easily and take over the race of sales in India.

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