Extended-range electric vehicle

Abstract

The main objective of this research is to extend the range of an electric vehicle to cover a required distance with minimum usage of energy at least cost. This is done by coupling an internal combustion engine to a generator which will charge the batteries, when the charge level of the batteries comes down.

Extended Range Electric Vehicle

1 Background

Extended-range electric vehicles (EREV): Extended-range electric vehicles (EREV) are the type of vehicles which run on electricity and a generator which is powered by either petrol or diesel. The generator is not used to run the vehicle whereas it helps in charging the battery when charge goes less than 30%. The term extended range is used to indicate that range of vehicle travel can be increased and this can be accomplished by using the above method. [9]

The normal electric vehicles are the ones which run only on the battery and when the charge depletes, we need to _nd a charging point and need to wait until it gets fully charged before continuing the travel. This type of vehicle is more suitable for short distance travel as this kind of vehicle will be having lesser range, when compared to other vehicles which runs on fuel.

The other kind of vehicles that are more recently being used is Hybrid vehicle. This is powered by combination of petrol or diesel engine and a battery [10]. The propulsion system will usually be of more than one type.

When charge runs out of the battery the internal combustion engine starts to work to power the vehicle and vice versa.

2 Literature Review

2. 1 Introduction:

The Extended Range Electric Vehicle (E-REV) is a unique kind of vehicle, where battery and internal combustion engine required for propulsion are sized in a way such that the engine will not be required for the vehicle operation when there is enough charge in the battery. There is no need to start the engine for any power or speed requirement. The only time the engine is used is to charge the battery when the charge depletes and becomes incapable of driving any further. [1]

Electric motors are more e_cient when compared to internal combustion engine with very high power-to-weight ratios which provides required torque when driving over a wide speed range. On the other hand internal combustion engines are e_cient when it operates at a constant speed. The working of internal combustion engine is more complicated when compared to electric motor [8]. The main advantage of using E-REV is the fuel consumption is saved as very little fuel is used to charge the battery. The bene_t is to both the people and society as running cost is reduced and on the other and the pollution from the vehicle is minimized.

The main problem with the fuel powered vehicles is the energy consumption is high. Energy production worldwide is growing annually by 2% as the demand is increasing due to population growth and industrial activities.

In this situation Electric Vehicles provide a very good means of transportation. And still we dont prefer electric vehicles because of their poor range, even the best electric scooters having a range of only 40km in real world conditions. This is one of the main disadvantages of electric vehicles/ scooters. In the present year due to depletion of fossil fuels, electric vehicle provide a clean mode of transportation. Since, these vehicles soul utilizes electricity for the transportation purpose, need of fossil fuel derivatives like gasoline and diesel are avoided. [3]

But battery operated vehicles (electric vehicles) have an uncertainty with respect to the distance travelled for a given charge level (range). In most of the cases the charge may not be su_cient to cover the desired distance which will fail the objective.

The main objective of EREV is to achieve larger distance with minimum usage of energy at least cost by taking electric scooter as a source. The solution will go like this- Coupling an Internal Combustion (IC) Engine to a generator (mobile type) which will charge the batteries, when the charge level of the batteries comes down. So while travelling, if the charge level comes down, IC engine will be turned ON and generator will charge the batteries until _nding a plug in source. [7]

In this IC engine is coupled with a Permanent Magnet Direct Current (PMDC) motor (which acts as a generator) and the whole set is mounted on the foot board of the electric scooter. Connections are made between the generator and batteries through a charging circuit (to avoid load uctuation).

In this _rst IC engine (Petrol/Kerosene run, 3000 rpm, and 1. 1 kW) is mounted on the foot board of an electric scooter. It can also be fabricated and placed under the seat, if the engine is small and portable

Then Flywheel of IC engine is connected to a PMDC Motor (60V, 5 amps @3000 RPM), the power developed at the ywheel was coupled to the PMDC Motor through the V Belt drive and a rated power output of 300 W (60V x 5A).

The connections were given to the batteries through a charging circuit which helps in developing the required current levels. Here 4 x 12V series connected batteries need to be charged which requires 1. 2 x 48 which is equal to 57. 6V and hence 60V PMDC Motor is used. And this is because of voltage drop on application of load.

2. 2 Scope:

- Improved e_ciency(RANGE)
- Increased energy security
- Decreased Emissions
- Reduced travel costs
- Engine can be detached for shorter distance
- Petroleum used is less

2. 3 Some of the challenges are:

- Charging time is more [2]
- Measuring fuel economy is di_cult
- need of extra space in the vehicle

- Limited weight carrying capacity
- Needs more space for the engine
- Initial high investment

Contents Features

Range 40-50 Kms

Top speede 40Km/hr

Charging Time 4-6 hours

Brakes 4 meter braking distance

Motor type Permanent magnet synchronous motor

Motor driving power 500W

Battery Sealed lead acid, 12V 17Ah in series

2. 4 Components Of Extended Range Electric Vehicle:

Fig-2. 1 Components of E-REV

There are two operation modes: the pure electric vehicle (EV) mode and the range extended electric vehicle mode. For daily short-distance travel, the vehicle operates in pure battery EV mode without the range extender. At weekend, you can assemble the range extender on the EV for a long distance travel.

The generator set is controlled with constant speed and its output is constant voltage and frequency, such as 220V, 50Hz. The output of the generator set

is connected to the interface of the charger. Unlike a conventional generator set, this generator set provides rated output by controlling the output current of the charger. This ensures that the generator set works at the highest e_cient point and has a low emission. The battery can also be charged by the charger with a household outlet or fast charged at charging station.

Percentage of EV mode driving determined by total distance driven beyond vehicles all electric range 35 miles of each segment would be driven in EV mode if:

- All charging events end with a full battery
- Vehicles EV mode range is exactly 35 miles

Of course EV mode operation varies based on charging duration, power level, battery state of charge at beginning of charge, driving style, conditions, etc. [6]

2. 5 Distance between charging events v/s Percentage of vehicles:

It is very important to note that about 32% of Electric vehicles o_er a range or distance covered per charge of about 40-45 kms.

To cover any distance beyond the normal range, the Electric vehicle has to be charged once again using a Plug-In source which is the main drawback of the electric vehicle which is need to be recti_ed.

2. 6 Ending State Of Charge (SOC) v/s Percentage of charging units:

From the below graph it is inferred that about 90% of the recharging event happens at home location, meaning that if the range of Electric vehicle is about 40km, then they end up in home before completing 40km to recharge.

This is one of the biggest disadvantages which hinder the use of Electric Scooter.[6]

2. 7 Charging Circuit Speci_cations:

12V Battery Maximum voltage for charging is 14. 5 Volts

Charging Current Maximum charging current should not exceed 10% of maximum A/H capacity of Battery.

Example: For 100AH Battery

10% = 100/10= 10A.

In the experiment 12V / 17AH battery is used.

Maximum Charging Current I = 17/10 = 1. 7 A.

Minimum Charging Voltage V = 2. 35 V /Cell x 6

= 14. 10 V

This means for four batteries,

= 14. 10 x 4

= 56 V

2. 8 Outcome:

- First, the cost required to travel 80 kms in a gasoline scooter is calculated for which cost comes around AUD 6.
- Next Conventional Electric scooter for which the experiment is conducted took about AUD 1 (Cost of Current) to cover the same distance.
- The main disadvantage is to _nd the plug-in source after the use of _rst charge which is about 40km’s. Then covering 80km’s in a single stretch is not possible.
- Then Extended Range Electric Scooter is used and the cost came around AUD 2 to travel the same distance.
- Here it runs as an electric scooter for _rst 40km and once the charge is empty, then the IC Engine-PMDC Motor setup is switched on mechanically to travel the next 40km.

2. 9 Features of the electric scooter:

- Power Consumption: One Unit (for complete charge).
- Safe speed and easy to drive.
- Low maintenance cost.
- 2 seater vehicle (The vehicle is designed to carry a maximum payload of 130 kgs.)
- For shorter distance engine can be removed and can run only on electricity.

3 Methodology

Fig-3. 1 Electric scooter with Range Extender

STEP 1: Mounting an IC engine (Petrol/Kerosene run, 3000 rpm, and 1. 1kW) on the foot board of an electric scooter.

STEP 2: Flywheel of IC engine is connected to a PMDC Motor.

STEP 3: The power developed at the ywheel was coupled to the PMDC Motor through the V Belt drive.

STEP 4: The connections were given to the batteries through a charging circuit which helps in developing the required current levels.

STEP 5: When the charge indicator shows charge is less, IC engine will be turned ON mechanically.

STEP 6: PMDC Motor will produce electricity to maintain the battery level until _nd-ing a plug in source.

STEP 7: The power developed from the engine generates electricity through the PMDC motor and charges the batteries through the Charging Circuit. The charging circuit charges the batteries at the rate of 3 A.

STEP 8: The Scooter will be tested for the improved range.

4 Conclusion and Summary

Based on the tests carried out to extend the range of the electric scooter as explained in the previous chapter and within the scope of this investigation the following conclusions have been drawn.

1. Initially the Electric scooter runs on Battery charge completely and when the charge is low, the IC engine runs the scooter by charging the batteries simultaneously.

2. The range of electric scooter is e_ectively increased by using IC Engine PMDC setup through the charging circuit.

3. The range of Extended Range Electric Vehicle(E-REV) is comparatively more than the conventional Electric vehicles.

4. On conducting tests with varying some of the parameter following observations is made:

When input current(amps) to the charging circuit increases, the time taken to charge the batteries decreases.

5. On the basis of comparison between the results obtained of Extended Range Electric Vehicle(E-REV) and conventional Electric Scooter it is clear that the distance covered per charge is comparatively more for E-REV.

References

[1] Extended-range electric vehicles (E-REV) https://www. goultralow. com/more-about-electric-cars/types-of-vehicles/range-extended/

[2] Beginner’s guide to electric cars – The Charging Point http://www. thechargingpoint. com/beginners-guide. html/

[3] Techsplanations: Extended-Range Electric Vehicles http://www. autoblog. com/2013/12/20/extended-range-electric-vehicles/

[4] Low-noise range extender dispels battery runtime angst http://www. rheinmetall-automotive. com/en/products/range-extender/

[5] Plug-in Hybrid Electric Vehicles (PHEVs) http://www. ieahev. org/about-the-technologies/plug-in-hybrid-electric-vehicles/

[6] Research gate http://www. researchgate. net/_gure/279853330-_g5-Figure-5-Distribution-of-distance-driven-per-vehicle-day-on-days-when-the-vehicle-was

[7] Hybrids explained: Mild v Full v Plug-in v Extended Range Electric Vehicle http://www. caradvice. com. au/279850/hybrids-explained-mild-v-full-v-plug-in-v-extended-range-electric-vehicle/

[8] Electric Cars: De_ning Battery-Electrics, Plug-In Hybrids, Range-Extended http://www. greencarreports. com/news/1098066-electric-cars-de_ning-battery-electrics-plug-in-hybrids-range-extended-more/

[9] Extended Range Electric Cars (E-REV) Doing away with Range Anxiety http://www. thegreenage. co. uk/extended-range-electric-cars-doing-away-with-range-anxiety/

[10] Electric vehicle range https://www. ergon. com. au/network/smarter-energy/electric-vehicles/electric-vehicle-range/