Development of Hybrid Bicycle using Stirling Engine: Concept

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Abstract— In India, nowadays there is request for electric bikes goes on increasing day by day. But according to the facility infrastructure and in considerations with India's best electric bikes, it is nearly impossible to use such electric bike for long journeys till today. Also such bikes take too much time for get fully charged. In order to minimize these drawbacks, we are going to see a concept of hybrid bicycle using Stirling Engine in this paper. The main reason behind to select Stirling engine is, it is ecofriendly and do not require any specific heat source as a fuel. In simple words, this concept belongs to the law of energy conservation.
Keywords: Hybrid Bicycle using Stirling Engine

I. INTRODUCTION

There are number of vehicles are available in India from different manufacturers. India has large numbers of vehicles driven by petroleum engines. These engines provide good output power and are useful in various road conditions. But this petroleum engine exerts various pollutants in to the environment. This leads to the pollution and affects living being. Now a day, to overcome this problem and to get more output hybrid vehicles exists in market. In case of two wheeled vehicles, the electric bike is a better alternative for petroleum vehicles.

As of today, most of the electric bikes are not suitable for long distance journey. And also the infrastructure for electric bike isn't good. Still India doesn't have availability of Recharging Stations, Service stations for Electric Bikes, Electricity for long time etc. so electric bikes are still not suitable for long range. In this dissertation we are going to discuss about an alternative based on electric bike. We are going to use Stirling engine with an alternator for the purpose of battery charging and keep bike in running condition for long journeys.

We are referring a working principle of Series Hybrid Electric Petroleum Bicycle (SHEPB). Only the difference between SHEPB and this current project is an engine used to generate power initially. We are going to discuss in details about the same in this dissertation below.

II. PROBLEM STATEMENT

As considering India's most efficient electric bike, it can run near about 100 kms per charge. And the time required for charging is minimum 6 hrs. On other hand, India is still developing country and still has number of problems regarding to electricity. Due to this unavailability of proper infrastructure for electric bikes, we can use these bikes for limited application. There is no any such bike is available in India which can be useful for long journeys. We can use petroleum hybrid bicycles for the same but it also leads to pollution too.

III. LITERATURE REVIEW

Paul Wolfram & Nic Lutsey [1] stated that It is found that carbon emissions of BEVs using European grid-mix electricity are about half of average European vehicle emissions, whereas HFCEVs and PHEVs have a lower emissions reduction potential. In the 2020 context, electric vehicle WTW emissions are expected to continue offering greater carbon benefits due to more efficient power trains and increasing low-carbon electric power. A lower-carbon grid and higher power train efficiency by 2020 could cut average electric vehicle emissions by one-third again. However, the expected cost reductions and potential CO2 emission cuts will not be achieved without targeted policy intervention. More stringent CO2 standards, and fiscal and non-fiscal incentives for electric vehicles, can help the electric vehicle market to grow and costs to fall. Also, efforts need to be combined with activities to decarbonize the grid, or emission reductions will not be as great as they could be. Although the analysis is focused on the European context, similar dynamics with electric vehicle technology, policy, and market development are prevalent across major markets in North America and Asia.

Paul Wolfram & Nic Lutsey [2] also stated about battery charging, there are three types of charging infrastructure for BEVs and PHEVs. Level 1 charging points provide alternate current power to the vehicle via a standard low-power 110 volt circuit, similar to those used in households in the United States or Japan. With these slow-charging points, more than 20 hours of charging are required to fully charge a 24 kWh battery. Residential or public Level 2 charging points in the United States provide alternate current power via a 240 volt (and 30 amp) circuit, and can thus cut charging time by about half. Level 2 charging via a 230 volt (and 15 amps) outlet is common in households in the EU and most other countries. Electrical panel upgrades are necessary in the United States to reach the same voltage. Level 3 charging points convert alternate current line voltage to a high-voltage direct current. Plugged into such a fast-charging point, a battery can be charged up to 80% (which is the recommended maximum level) within half an hour (NAS, 2013). However, the investment cost of Level 3 chargers is much higher than those for Level 1 and 2.

R. D. Belekar, Shweta Subramanian, Pratik Vinay Panvalkar, Medha Desai, Ronit Patole [3], stated that the chassis of a commercially available motorcycle is modified as per the requirements of the battery sizes and the self-charging system. The components like alternator, motor and DC-DC converter was arranged in a manner to transfer the rotational energy being experienced by the chain sprockets through the chain to the alternator. The alternator here has the capacity to produce 14.4V DC, which is directed to DC-DC converter through a battery source. Here in DC-DC

converter the voltage source is stepped up to 54V, which is enough to charge the 4 batteries in series which yields to 48V usage. Thus the batteries which are used to provide the rotational energy to the shaft through a motor is receiving back the sufficient voltage source to recharge it. The vehicle is tested for the supply of source to the batteries using multi-meter, distance travelled with and without the recharging circuit is also studied and is found to be effective.

Boopathi S, Saranya A, Raghuraman S, Revanth R [4] At a time when there is energy crisis casting its shadow all over the world, one has to look into alternator renewable energy sources. One such alternator way to generate power is presented in this paper. The rotating energy of the tries in the bicycle, generated by dynamo can be used to operate small powered devices. The issues associated with electric bicycles may be addressed by custom-designed drives that are most efficient over a given operating cycle. The results of the studies listed here can serve as a platform to improve electric bicycle performance, if new drive systems are designed around key parameters that will result in improvement of the system performance. Furthermore, they can be used for comparison of existing drives in a systematically, comprehensive, and technical way.

Shete Yogesh Shreekrushna, Londhe Vishal Ramchandra, Bhosale Yogesh Jalindar, Asst. Prof. Mujawar A. I. [5] Series Hybrid Electrical Petroleum Bicycle system is a type of hybrid system, in which a bicycle works by using electricity until battery get discharged and then generator gets started to charge the battery and also to keep vehicle in running condition during the journey. This vehicle is mostly electric vehicle which also have a plug-ins provided for the charging of battery by providing supply. This may be called as Plug in hybrid electric vehicles (PHEV). These consists the batteries having extended capacity. PHEV runs on battery throughout the journey, but at the end of journey, it shifts to engine to overcome the possibility of overcharging. Basically PHEV requires less mechanical linkages, so the system becomes easy and simple.

Darshil G. Kothari, Jaydip C. Patel, Bhavik R. Panchal [6] stated that it is a way of using the outgoing power. The concept of the project is providing ease to the rider while riding a bicycle and also to conserve energy by all possible means. When the solar electric bicycle is kept under sunlight then the solar rays charge the battery through the solar panel. The battery powers an electric motor in the motor of wheel. It also lowers the resistance in pedaling to make it easier to go up hills. When there is no sunlight, the bicycle can be charged by mains electricity. The hybrid bicycle approach is different. It works in normal day as well as in cloudy day. We have designed an electric hybrid bike with a minimal amount of additional weight, an integrated control system, based on the decision-making of the rider and microcontroller, and that is capable of greater efficiency than typical hybrid bikes through its use of regenerative motor control and various other feedback control mechanisms.

IV. RELEVANCE

In this section, we are going to discuss about basics of components going to be used in this concept as well as we are also going to discuss about relevant components,

A. Electric Vehicle:

An electric vehicle, also called an electric drive vehicle, uses one or more electric motors or traction motors for propulsion. An electric vehicle may be powered through a collector system by electricity from off-vehicle sources, or may be self-contained with a battery, solar panels, or an electric generator to convert fuel to electricity. EVs include road and rail vehicles, surface and underwater vessels, electric aircraft and electric spacecraft. EVs first came into existence in the mid-19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. Modern internal combustion engines have been the dominant propulsion method for motor vehicles for almost 100 years, but electric power has remained commonplace in other vehicle types, such as trains and smaller vehicles of all types. In the 21st century, EVs saw resurgence due to technological developments and an increased focus on renewable energy. Government incentives to increase adoptions were introduced, including in the United States and the European Union.

B. Hybrid Vehicle:

A hybrid vehicle uses two or more distinct types of power, such as internal combustion engine to drive an electric generator that powers an electric motor, e.g. in diesel-electric trains using diesel engines to drive an electric generator that powers an electric motor, and submarines that use diesels when surfaced and batteries when submerged. Other means to store energy include pressurized fluid in hydraulic hybrids. There is variety of types in hybrid vehicles. Mopeds, electric bicycles, and even electric kick scooters are a simple form of a hybrid, powered by an internal combustion engine or electric motor and the rider's muscles. Early prototype motorcycles in the late 19th century used the same principle.

C. Stirling Engine:

A Stirling engine is a heat engine that is operated by a cyclic compression and expansion of air or other gas (the working fluid) at different temperatures, such that there is a net conversion of heat energy to mechanical work. More specifically, the Stirling engine is a closed-cycle regenerative heat engine with a permanently gaseous working fluid. Closed-cycle, in this context, means a thermodynamic system in which the working fluid is permanently contained within the system, and regenerative describes the use of a specific type of internal heat exchanger and thermal store, known as the regenerator. Strictly speaking, the inclusion of the regenerator is what differentiates a Stirling engine from other closed cycle hot air engines. Originally conceived in 1816 as an industrial prime mover to rival the steam engine, its practical use was largely confined to low-power domestic applications for over a century.

There are various types of Stirling Engine these are,
1) Alfa Stirling
2) Beta Stirling
3) Gamma Stirling
4) Rotary Stirling
5) Fluidyne Stirling
6) Franchot Stirling

D. Alternator:

Increasing electricity demand in automotive applications led to the development of the three phase alternator which supersedes the DC generator. The automotive DC generator has deficiencies of zero output at idle and the need for maintenance due to full electrical output being passed through a commutator. The development of semiconductor diodes meant the alternating current of AC machines could be reliably rectified in a solid state diode bridge allowing cheap production of compact and reliable three phase alternators.

E. Batteries:

Generally, in this type of electric bike traction batteries are used. These batteries have an ability to remain charged for very long time in comparison to lead-acid battery.

V. METHODOLOGY

A. Concept:

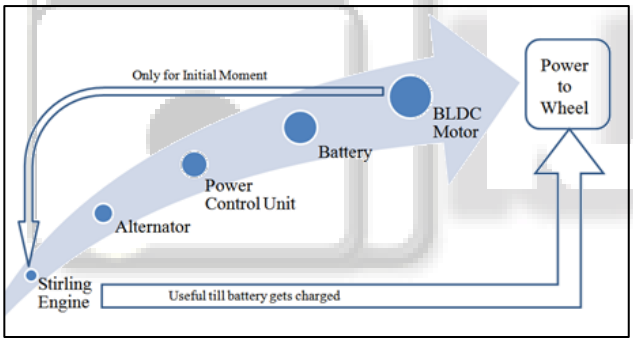

Fig. 1: Concept

We are going to use the similar technology used in the Series hybrid Electric Petroleum Bicycle. In such type of vehicle, initially the power gets generated by using engine. This power gets utilize for the running the vehicle. Simultaneously, this power gets used for battery charging through alternator. In this type of vehicle, we are going to use Stirling engine for initial power generation as well as to charge vehicle. When bicycle runs over the power generated by Stirling Engine, on the other hand power control unit divides the power to charge the batteries. After getting batteries fully charged, power control unit will pass the signal to indicator, and then engine power should be get cut off. After cutting engine power, vehicle runs over batteries and BLDC.

B. Construction:

There are following components of our this conceptual model,
1) Stirling Engine
2) BLDC Motor
3) Alternator
4) Chassis / Frame
5) Battery
6) Power Control Unit
7) Chain Sprocket
8) Indicators / Displays

C. Working:

This bike works on the principle of conservation of energy. Here in this type of bike, Stirling engine is used as a primary source of energy. This generated energy is utilizes to run bike as well as to run alternator. For this we are going to couple these three flywheels i.e. a flywheel of engine, drive of bike and alternator flywheel with the help of belt. On the other hand BLDC motor is also coupled to the wheel hub. When an engine is in working condition and it drives the wheel, it makes rotation of motor due to coupling.

VI. CONCLUSION

In this paper we have seen, how it will be used and maintain. So by using this concept, definitely we can achieve higher efficiency from the electric bike and also overcome the drawback of unavailability of infrastructure for electric vehicles. With reference to SHEPB, this will work as effectively as hybrid bike with petroleum engine but will make less pollution than the same.

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