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Exploring Electric Vehicles: Functioning, Comparisons, and Future Prospects

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Abstract: The detrimental impacts of gasoline-powered vehicles on the environment and human health have prompted the automotive industry to transition to electric vehicles (EVs). This report aims to elucidate the functionality of EVs and draw comparisons with internal combustion engines (ICEs) and hybrid vehicles. Furthermore, it explores the advantages and disadvantages of EVs, along with insights into the future prospects of this technology. EVs exhibit significantly higher efficiency than ICEs, efficiently converting more energy from the grid to power the wheels. They also offer instant torque, enabling swift acceleration and a smoother driving experience. Although EVs may have limitations such as limited range and higher upfront costs, their numerous benefits in terms of sustainability, efficiency, and reduced emissions establish them as a viable alternative to traditional gasoline-powered vehicles.

Keywords: Electric vehicles (EVs), Internal combustion engines (ICEs), Hybrid vehicles, Sustainability, Emissions

I. INTRODUCTION

India's automotive market has experienced significant growth driven by a burgeoning middle-class population and steady economic development. However, escalating petrol prices, mounting environmental concerns, and the demand for sustainable transportation solutions have ignited a growing interest in electric vehicles (EVs) in India. This report aims to provide a comprehensive understanding of EV technology, emphasise the advantages of electric engines over internal combustion engines (ICEs), and explore the driving forces behind the rapid growth of EVs as a necessity for a better world.

The historical evolution of electric vehicles traces back to the mid-19th century when they emerged as a preferred mode of transportation due to their comfort and ease of operation. While internal combustion engines dominated the automotive industry for almost a century, electric power continued to be prevalent in other vehicle types, such as trains and smaller vehicles. Electric vehicles, also known as electric drive vehicles, rely on one or more electric motors or traction motors for propulsion. They can be powered by electricity from external sources or self-contained with a battery or generator that converts fuel to electricity. This section provides an overview of the essential components of an electric vehicle, their functions, and the underlying theory of operation.

Hybrid vehicles act as a bridge towards full electrification and serve as an intermediate step in the transition. This section explains the concept of hybrid cars, delving into their components, functions, and operational principles. By combining an internal combustion engine with an electric motor, hybrid vehicles offer enhanced fuel efficiency and reduced emissions compared to conventional gasoline-powered vehicles. It highlights the advantages of electric vehicles in terms of energy efficiency, instantaneous torque delivery, and lower maintenance costs.

Electric vehicles exhibit a significantly lower environmental impact compared to their gasoline-powered counterparts. By producing zero tailpipe emissions, EVs contribute to cleaner air quality and reduce health risks associated with particulate matter and carcinogens emitted by ICE vehicles. This section discusses the environmental benefits of EVs and their positive impact on public health.

While EVs offer numerous advantages such as reduced emissions, quieter operation, and potential long-term cost savings, challenges like limited charging infrastructure and higher upfront costs are also addressed. The report explores government initiatives, incentives, policies aimed at promoting EV adoption, and the projected growth of charging infrastructure. Additionally, it touches upon emerging technologies like solid-state batteries and increased range capabilities that will shape the future of electric mobility in India.

Electric vehicles have emerged as a viable and sustainable alternative to traditional internal combustion engines. Within the context of India's automotive market, EVs provide a solution to rising petrol prices, environmental concerns, and the necessity for a cleaner and greener transportation system. While the initial investment for an electric vehicle may be higher, the long-term benefits in terms of reduced emissions, improved air quality, and potential cost savings make EVs an indispensable part of the future of the automotive industry.

II. BASIC SCHEME

1. The proposed idea of an electric vehicle is particularly suitable for locations where the price of petrol and diesel is high and flue gas has a high emission rate.
2. This scheme involves generating electricity through a dynamo.

III. WORKING OPERATION

Several key components, including an electric motor, a controller, and a rechargeable battery pack, facilitate an electric vehicle's (EV) operation. The electric motor serves as the primary source of propulsion in an EV, converting electrical energy into mechanical energy to drive the vehicle's wheels.

Working in tandem with the electric motor, the controller plays a crucial role in managing the power flow between the battery pack and the motor. It receives power from the battery pack and regulates the current and voltage supplied to the motor based on various factors, such as the position of the accelerator pedal and the vehicle's speed.

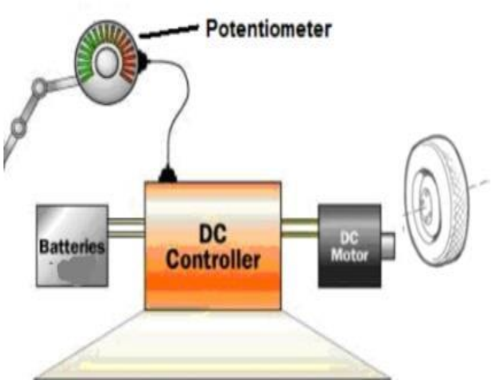

Figure 1: Basic Block Diagram of an Electric Vehicle

Figure 2: Chassis of the Vehicle

The rechargeable battery pack is an essential component of the electric vehicle (EV) as the energy storage system. Lithium-ion batteries typically store electrical energy later utilised to power the electric motor through the controller. The capacity and performance of the battery pack directly impact the driving range and overall efficiency of the EV, making it a crucial aspect of the vehicle's design.

Variable potentiometers, commonly linked to the accelerator pedal, play a significant role in controlling the speed and power output of the electric motor. These potentiometers transmit signals to the controller, indicating the driver's desired power level or speed. By adjusting the position of the accelerator pedal, the driver can effectively regulate the amount of power delivered to the motor, providing control over the vehicle's acceleration and speed.

The electric motor converts electrical energy into mechanical energy, enabling the vehicle to move without relying on a conventional gasoline engine. This conversion process reduces emissions and is quieter than internal combustion engine vehicles, contributing to a cleaner and more environmentally friendly transportation system.

IV. DESCRIPTION OF PARTS AND THEIR FUNCTIONS

a) Potentiometer: The potentiometer is a circular component connected to the accelerator pedal. It serves as a variable resistor and provides a signal to the controller, indicating the desired power level to be delivered.

Parameter	Value
Supply Voltage (V)	48
Return Voltage (V)	4
Max. Load Output Current (A)	15.625
Handle Bar Diameter (mm)	22
Three wires (red, green, black)	48 v Supply

b) Batteries: The batteries supply power to the controller. Three common types of batteries used in electric vehicles are lead-acid, lithium-ion, and nickel-metal hydride batteries. The voltage and power capacity of batteries can vary.

c) Battery Specification: The power of the battery is determined by the product of its voltage and current (P = V x I). For example, to drive a 750W motor with a voltage of 48V, four batteries of 12V and 33Ah are selected and connected in series to achieve the required voltage of 48V for the motor.

d) Electrical Charging: The time required to charge the batteries fully is calculated based on the power supplied during AC charging. Assuming an AC adapter specification of 48V and 5A, the power (P) is calculated as the product of voltage (V) and current (I) (P = V x I). In this case, P = 48V x 5A = 240W. Therefore, the time required to charge the batteries completely is calculated as t = 720Wh (total battery capacity) divided by 240W (charging power), resulting in a charging time of 3 hours.

Hence, based on the calculations, it is found that the batteries require approximately 3 hours to charge completely.

IV. DC CONTROLLER

The DC controller plays a crucial role in the powertrain system of an electric vehicle. It is an intermediary between the batteries and the electric motor, enabling precise and controlled power delivery. The controller's versatile capabilities allow it to supply varying power levels based on the driver's input.

When the electric vehicle is stationary, the controller delivers zero power to the motor. The controller responds accordingly as the driver presses the accelerator pedal, signalling the desired power output. For example, pushing the accelerator pedal to its maximum activates the full power output from the controller.

In situations where the accelerator pedal is pressed at a partial position, such as 25 percent, the controller utilises a technique called pulse modulation. This technique involves cycling the power output on and off, with a specific on-time and off-time ratio. In this case, the power would be cycled on 25 percent of the time and off 75 percent of the time, ensuring the desired power level is maintained.

However, it is crucial to highlight that the operation of the controller relies on the signals received from the two potentiometers connected to the accelerator pedal. These potentiometers provide input to the controller, indicating the driver's desired power level. To ensure safety and prevent potential issues, the controller compares the signals from both potentiometers. If the signals are not equal, indicating a fault or discrepancy, the controller inhibits motor operation to prevent any potential hazards.

Once the controller supplies power to the electric motor, the motor then drives a transmission system. The transmission system transmits the rotational force from the motor to the wheels, enabling the electric vehicle to move forward.

The DC controller is vital in managing the power flow and delivering precise power levels to the electric motor based on the driver's input. It relies on signals from the accelerator pedal potentiometers and ensures safety through its monitoring capabilities. The power delivered by the controller drives the transmission system, allowing the electric vehicle to move efficiently and smoothly.

Figure 3: DC Motor Controller

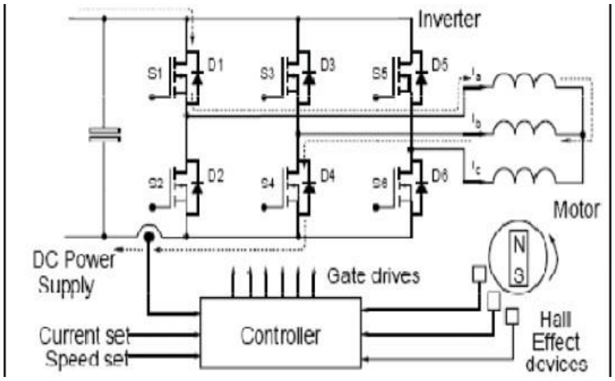

Figure 4: Controller Block Diagram

Motor: The motor receives power from the controller and turns a transmission, which drives the vehicle's wheels. The following calculations determine the motor's torque, speed, and power requirements.

To calculate the torque required for the motor, we consider the friction force acting on the tire, which is determined by the coefficient of friction (μ) and the normal reaction force (N1). With a coefficient of friction of 0.3 and a normal reaction force of 853 Newton, the friction force is calculated as $F = 0.3 \times 853 = 255$ N. The torque required is then calculated using the formula $T = F \times r$, where r is the radius. Assuming a radius of 0.19 meters, the torque required is $T = 255 \times 0.19 = 49$ Nm.

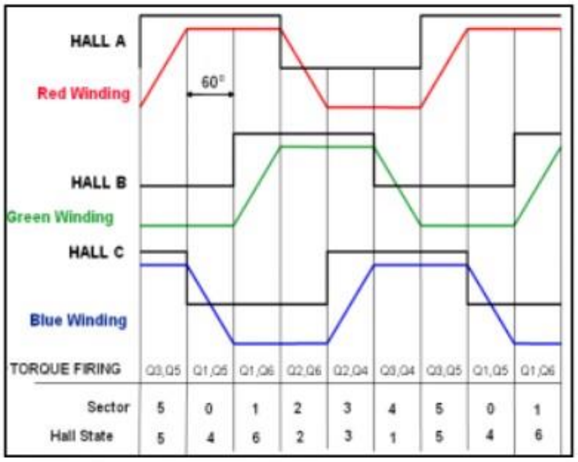

Figure 5: Output Voltage Pattern Graph

Figure 6. Hub Motor Block Diagram

To determine the speed of the motor, we use the formula $\omega = v \div r$, where ω represents angular velocity, v is the linear velocity, and r is the radius. Assuming a linear velocity of 10 m/s and a radius of 0.19 meters, the angular velocity is calculated as $\omega = (10 \times 1000) \div (0.19 \times 3600) = 14.61$ rad/sec. Converting this to revolutions per minute (rpm), we use the formula $N = (60 \times \omega) \div (2\pi) = 140$ rpm.

We use the formula P = (2πNT) ÷ 60 for power calculations, where P represents power, N is the speed in rpm, and T is the torque. Plugging in the values, we get P = (2π x 140 x 49) ÷ 60 = 720 Watts (Approximately). Thus, a motor with a power rating of 750 W is selected as a suitable option for the Solar EV.

It's important to note that solar power is used as supplementary energy to power the Solar EV, with the motor serving as the primary power source.

V. SOLAR PANEL

A solar panel is a photovoltaic converter that harnesses solar energy. However, it only operates effectively in bright sunlight. The solar panel does not generate electricity if the sun's rays are blocked by clouds or during nighttime. A solar charger is incorporated to overcome this limitation and make solar energy available throughout the day.

Maximum Power (Watt)	75 W
Charging current (Amp)	4.16
Open Circuit Voltage (V)	25
Max Power Voltage (V)	18 V
Short Circuit Current	8.31
Power Measured at Standard Test Condition	1000 W/m^2 at 25°C
Lifespan	25 years

VI.SEQUENTIAL SWITCHING CIRCUIT

The sequential switching circuit will facilitate the switching between the solar panel and the battery. The battery will be connected to the solar panel alternately for a duration of 10 minutes each time.

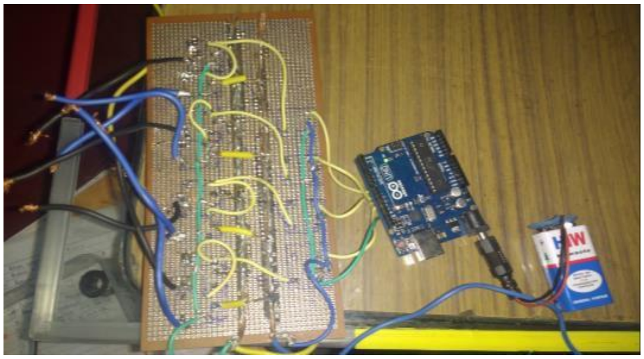

Figure 6: Sequential Switching Circuit

VII. EMISSIONS

Electric vehicles (EVs) are widely recognised as being significantly cleaner than gasoline-powered vehicles, with estimates suggesting they are approximately ninety-seven percent cleaner. One of the main reasons for this is that EVs produce zero tailpipe emissions, unlike their gasoline counterparts. Tailpipe emissions from gasoline vehicles contribute to air pollution and can release particulate matter into the atmosphere, which harms human health. Additionally, the process of burning fossil fuels in gasoline vehicles emits carbon dioxide (CO2), a greenhouse gas responsible for global warming. The impact of global warming includes the depletion of the Earth's ozone layer. By opting for EVs, which do not emit CO2 during operation, we can help mitigate global warming and indirectly contribute to preserving the ozone layer. Another advantage of EVs is their simplified design, which requires fewer parts than gasoline vehicles. This means reduced consumption of resources like gasoline and oil, further enhancing their environmental cleanliness. As we transition towards electric vehicles and cleaner energy sources, we can significantly reduce our environmental footprint and work towards a more sustainable future.

Figure 8: Final Image of the Vehicle

VIII. CONCLUSION

This report observes that electric vehicles have numerous advantages and benefits over internal combustion engines. They are cleaner and much more efficient but also have certain disadvantages. They tend to be heavier, have a limited range before requiring a recharge, and cost more. The future of electric vehicles largely depends on advancements in battery technology. If researchers can develop or discover a "super battery," the future of EVs will be promising. Currently, each type of vehicle has the characteristics that make it better than the others. Only time and technological improvements will determine which vehicle will excel. The proposed project named "ELECTRIC VEHICLE" aims to provide an alternative source of transportation and an economical solution. If effectively used, we believe this project could be considered innovative and a good solution for reducing CO2 emissions, particularly in developing nations like India.

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