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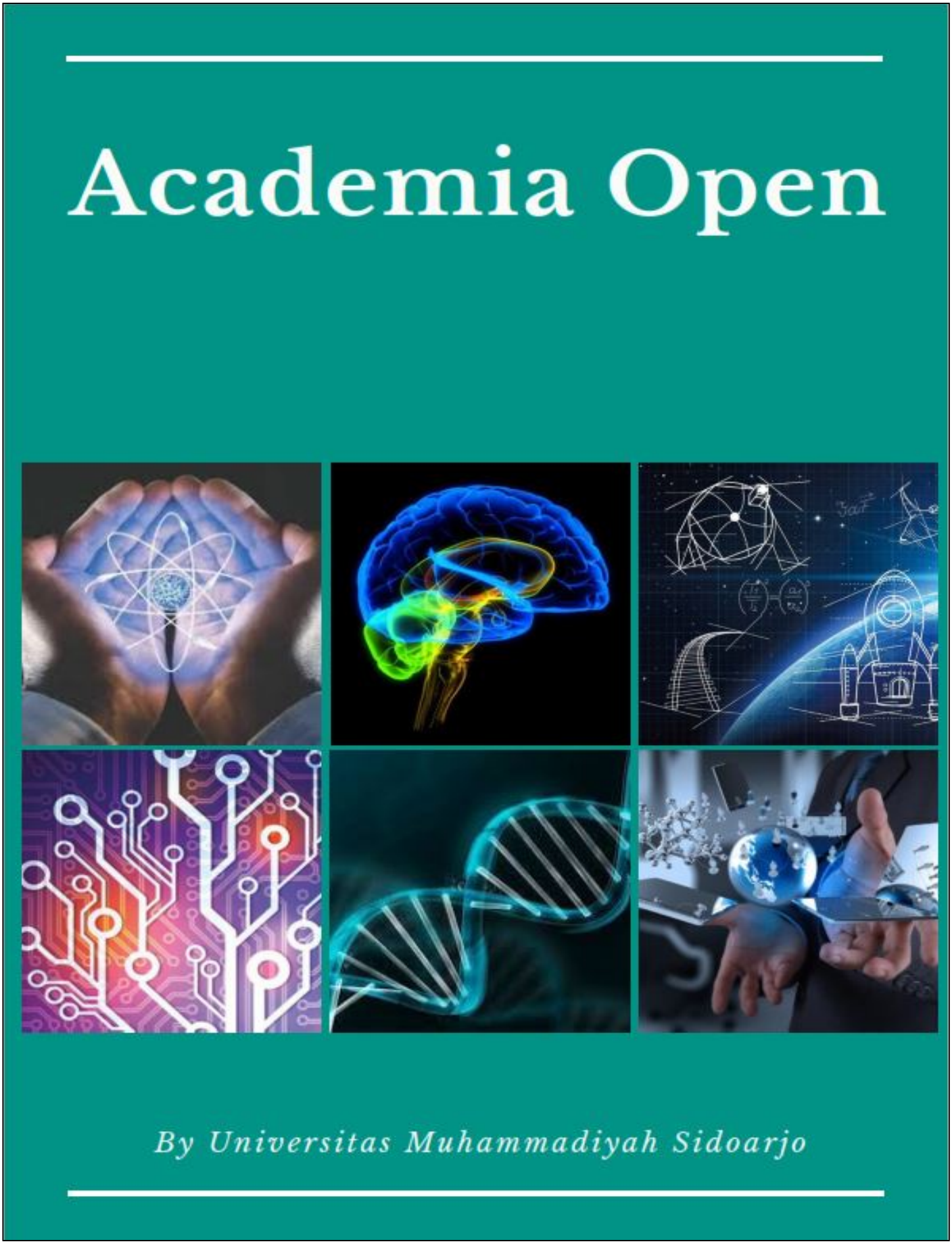

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Hybrid Vehicles: An Analysis of Efficiency and Environmental Impact

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Abstract

This study examines the advantages and disadvantages of hybrid vehicles, focusing on their capacity to mitigate harmful emissions and improve fuel efficiency. It discusses the operating principles of internal combustion engines, electric motors, inverters, and batteries used in hybrid vehicles, illustrating their key roles in improving environmental sustainability. The research analyses three power device interconnection schemes: series, mixed, and parallel, exemplified by Chevrolet Volt and Honda models respectively. The results indicate that despite high upfront costs, hybrid vehicles significantly reduce harmful emissions and fuel consumption, particularly in urban driving conditions. Furthermore, their positive environmental impact and fuel economy potentially position hybrid vehicles as future market dominants. The study highlights the importance of hybrid vehicles in mitigating climate change and calls for continued advancements and global investment in this promising technology.

Highlights:

1. Hybrid vehicles significantly reduce harmful emissions and improve fuel efficiency, particularly beneficial in urban environments.
2. Three power device interconnection schemes (series, mixed, and parallel) dictate the operational characteristics and efficiency of hybrid vehicles.
3. Despite the initial high investment, the long-term benefits of hybrid vehicles such as lower fuel consumption and environmental impact could make them a dominant player in the future automotive market.

Keywords: Hybrid Vehicles, Internal Combustion Engine, Electric Motor, Emission Reduction, Fuel Efficiency.

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Introduction

Internal combustion engines are widely used as an independent energy source in traditional vehicles. The advantage of internal combustion engines is that they are easy to maintain, and of course the type of fuel (gasoline, diesel, gas, etc.) can be changed at the expense of a small modification. However, as the type of fuel changes, toxic gases are released into the atmosphere due to the chemical reaction and heat energy that occurs during the operation of an internal combustion engine. In turn, a lot of work is being done to reduce vehicle emissions [1].

We want to offer hybrid cars that move in urban conditions or replace vehicles in order to reduce the toxic gases emitted from vehicles.

On city roads if you pay attention to traditional cars the process of movement takes place over a long period of time. There are many examples of this. For example: congestion, the location of traffic lights at very close intervals and, of course, the abundance of vehicles on city roads.

The engines of modern vehicles are powerful enough to provide dynamic and safe movement. However, speed is limited when driving on city streets, which results in an increase in the engine engine's loading time and, of course, an increase in fuel consumption. The constant change of acceleration and deceleration processes results in the loss of 70% of the fuel energy used to accumulate the car's kinetic energy during the car's deceleration. The car does not move in parking lots, the energy of internal combustion engines is wasted, so the priority in the design of cars is to reduce the amount of harmful substances and increase fuel economy and engine efficiency. Making these routes a common task seems important, as a reduction in the amount of fuel required to obtain the vehicle's driving energy results in a corresponding reduction in the amount of harmful emissions [2].

Discussion

It is known that today in developed countries, many car manufacturers are actively working to introduce the production of hybrid cars. Their creation requires a lot of money, but it has become clear that fuel economy and low environmental impact will soon lead these cars to take their place in the market.

The word "hybrid" is derived from the Latin word meaning a mixture, or a combination of different elements. In the case where hybrid cars have two types of engines (in some cases there may be more), these engines include the following. It consists of an internal combustion engine and an electric motor.

Unlike a conventional car, a hybrid car does not have to ignite it during start-up, allowing maximum traction by means of a torque transmission to the leading wheels by starting the electric motor.

Another advantage of an electric motor over an internal combustion engine is that it frequently changes the operating process and is more efficient in standby mode. It creates great opportunities to move on city roads.

What are the components of a hybrid car: a) internal combustion engine; b) electric motor; c) inverter; d) battery [3].

Diesel, gasoline, gas and other types of engines can be used as internal combustion engines.

As an electric motor, we use variable and fixed electric machines according to the system we have chosen.

Lead-acid and alkaline (eg lithium ion) batteries are currently used as a source of electricity.

In short, a hybrid car allows you to combine the positive aspects of an internal combustion engine and an electric motor. The advantages of hybrid vehicles are that the gases emitted from their engines are environmentally friendly, fuel-efficient, and most importantly, they can transport the car from one place to another without fuel.

Hybrid cars are divided into three schemes on the interconnection of power devices: series, mixed and parallel.

In most of the existing hybrid cars, serial connection of power devices is less common in light cars. Chevrolet has taken a unique approach to creating a hybrid car. During the series connection, the electromotive torque is transmitted to the leading wheels, while the small-capacity internal combustion engine rotates the generator, which generates electricity. There is no need for a gearbox and a powerful internal combustion engine, but there is a need for a large-capacity battery.

Technically, the Chevrolet Volt is a four-seater hatchback with a gross vehicle weight of 1,715 kg. designed to reduce the aerodynamic drag of the car body as much as possible. The traction coefficient of the car is 0.29 [13].

The power unit includes a 1.4-liter gasoline engine with a displacement of 86 horsepower, a traction electric motor

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with a maximum power of 151 horsepower and a motor-generator that produces 368 N / m of torque and 73 horsepower. The main current source is a lithium-ion weighing battery with a capacity of 16 kW / h. The battery is located under the car and weighs about 200 kg and consists of 288 elements.

The ignition process of the car is started with the ignition button and can reach the maximum frequency of revolutions in a few seconds. The electric motor and motor-generator are combined in one block and connected to the internal combustion engine as a gearbox. Their interconnection is provided by a planetary reducer.

The most common scheme today is the 1905 patented by German scientist Henry Pupper. The parallel circuit is equipped with an electric motor (10-15 kilowatts) that collects recuperative energy during braking, assisting the internal combustion engine in gaining speed. A variator or planetary transmission can usually be used as a transmission.

Honda's powertrain is a prime example of a parallel circuit hybrid. At the same time, an electric motor-generator was installed on the crankshaft of the engine instead of a flywheel, which created and simplified some conveniences. This model can not only be powered by an internal combustion engine but also travel 50 km with an electric motor when it runs out of fuel. Honda used lithium-ion or lithium-polymer batteries as a power source.

Hybrid cars are most popular today in the US and Canada. But it should be noted that quite a few Western countries have turned their gaze towards a new generation of machines. This is primarily due to the environmental friendliness and efficiency of such vehicles. Hybrid cars were first mass-produced in Japan when Toyota first launched its first Prius and then the Lexus RX400h crossover. Further, the Volvo Group picked up the trend, starting the production of hybrid trucks and transport vehicles.

Those who decide to purchase a hybrid car should familiarize themselves with the rating of the most popular and practical vehicles, which also have the best environmental performance, namely:

Toyota Prius Hybrid is the "father" of modern hybrid cars. Although the car cannot boast of a particularly attractive design, it has such advantages as low fuel consumption (about 4 liters per 100 km) and reliability [14].

Hyundai loniq Hybrid is a Korean novelty in the Russian market. This is the first hybrid of the concern, the main advantage of which is high environmental friendliness. The car has rich technical equipment and original design. High-speed qualities and excellent handling are a big plus.

The Toyota RAV4 Hybrid crossover is a hybrid version of the Japanese internal combustion engine car, which, according to external data and overall dimensions, is almost identical to it. The advantage and distinguishing feature of the car is reduced fuel consumption and a much smaller amount of emissions of harmful substances into the atmosphere.

Conclusion

The Chevrolet Malibu Hybrid and the Ford Fusion Hybrid represent distinct developments in hybrid vehicle technology, both providing substantial benefits in terms of fuel efficiency, design, and safety. The Chevrolet Malibu Hybrid is a spacious sedan distinguished by its distinct design, advanced interior features, and comprehensive safety system, including ten airbags and a rearview camera. On the other hand, the Ford Fusion Hybrid is a mid-size sedan that offers cost-effectiveness, both in terms of initial pricing and future fuel savings, making it an attractive option for families. Hybrid vehicles typically utilize power transmissions in series or parallel connections, or a combination thereof. Despite the underlying similarity, each hybrid vehicle manufacturer implements unique strategies and technologies, leading to a rich diversity in the hybrid vehicle market. While existing research has provided valuable insights into the operation and benefits of hybrid vehicles, future studies should continue to explore the implications of these differing approaches on vehicle performance, fuel efficiency, and overall consumer satisfaction.

References

1. A. A. Mitaishvili, "Ekonomicheskie Problemy Razvitiya Transporta," Transport, Moscow, 1982.
2. V. Rakov, "Hybrid Car," LAP Lambert Academic Publishing, 2012.
3. O. P. Bajinov and S. A. Smirnov, "Hybrid Car XNADU," 2008.
4. Ju. Fedotova, "Hybrid Cars: Present and Future," Ajmpress, 2005, no. 5 (49), pp. 23–27.
5. G. Becerra, L. Alvares-Icaza, I. Flores De La Mota, and J. L. Mendoza-Soto, "Simulation and Optimization Applied to Power Flow in Hybrid Vehicles," in Applied Simulation and Optimization, Springer, Cham, 2017.
6. J. Hellgren and E. Jonasson, "Maximisation of Brake Energy Regeneration in a Hybrid-Electric Parallel Car," International Journal of Electric and Hybrid Vehicles, vol. 1, no. 1, 2007, pp. 95–121.
7. D-H. Kim, J-M. Kim, and S-H. Hwang, "Optimal Brake Torque Distribution for Wheel Drive Hybrid Electric Vehicle Stability Enhancement," Proceedings of the Institution of Mechanical Engineers, Part D: Journal of

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Automobile Engineering, vol. 221, 2007, pp. 1357–1366.
8. M. A. Masrur and V. K. Gard, "Hybrid Electric and Hydraulic Technology Applications in Off-road Vehicles," in Encyclopedia of Sustainability Science and Technology, Springer, New York, 2012.
9. "What is a Hybrid Car?" o2.edu.vn. Available: https://o2.edu.vn/what-is-a-hybrid-car/. [Accessed: 11-Mar-2022].
10. D. Eiranova, "Types of Motors Used in Hybrid Cars," itstillruns.com. Available: https://itstillruns.com/types-motors-used-hybrid-cars-5583523.html.
11. Pro Auto, "Varieties of Hybrid Cars. How do They Work and How do They Differ from Each Other," dzen.ru. Available: https://dzen.ru/a/XqSouD7Lex6m6mix.
12. "Hybrid Electric Vehicles in the US," Wikipedia. Available: https://en.wikipedia.org/wiki/Hybrid_electric_vehicles_in_the_US.
13. N. K. Sobirzhonovich, "About the Operating Principles of Hybrid Engines," sci-article.ru. Available: https://sci-article.ru/stat.php?i=1506501636. [Published: Sep-2017. Last edited: 07-Oct-2017].
14. "Chto Takoe Gibridnyy Avtomobil? Kak On Rabotaet, Preimuschestva I Nedostatki," auto.rambler.ru. Available: https://auto.rambler.ru/navigator/42693429-chto-takoe-gibridnyy-avtomobil-kak-on-rabotaet-preimuschestva-i-nedostatki.

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