Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 44 No. 6 (2023)

Understanding Green Propulsion: A Conceptual Study

Dr. Parvez Alam Khan

Assistant Professor

Atria University, Bengaluru

***Abstract*:**

Green propulsion systems are becoming increasingly important in the context of sustainable development and environmental protection. This conceptual study aims to provide a comprehensive understanding of green propulsion by exploring various aspects related to its technology, environmental impact, challenges, and future prospects. The study begins by defining green propulsion and identifying its different types, including electric propulsion, hydrogen fuel cells, biofuels, and solar propulsion. It then discusses the environmental benefits of green propulsion, such as reduced greenhouse gas emissions and air pollution, compared to traditional propulsion systems. Technological challenges associated with green propulsion, such as energy storage, infrastructure development, and cost-effectiveness, are also examined. The study highlights the regulatory environment surrounding green propulsion, including government policies and incentives aimed at promoting its adoption.

Keywords: *green propulsion, challenges, government policies*

Introduction:

Traditional propulsion methods utilised by sectors including the automobile, aircraft, and marine industries have come under increasing scrutiny in light of rising environmental concerns in recent years. Greenhouse gas emissions and air pollution are key contributors to climate change and environmental deterioration. The transport industry is a particularly big culprit in this regard. There has been an upsurge in research and development of environmentally friendly propulsion systems as a solution to these problems.
The goal of green propulsion systems is to lessen or eliminate the negative effects that propulsion systems have on the environment. This is achieved by the utilisation of renewable energy sources, enhancement of fuel efficiency, and reduction of emissions. These solutions can greatly aid in the attainment of sustainability objectives and may even cause a revolution in the transportation industry.
By delving into several facets of green propulsion systems' technology, environmental effect, obstacles, and potential, this conceptual study seeks to offer a thorough grasp of these systems. First, the many forms of green propulsion will be defined and listed in the study. These forms include electric propulsion, solar propulsion, biofuels, hydrogen fuel cells, and electric propulsion. Green propulsion has fewer negative effects on the environment than conventional propulsion methods, including less air pollution and greenhouse gas emissions. Energy storage, infrastructure development, and cost-effectiveness are some of the technological obstacles that green propulsion faces, and these will be investigated in the study. Government strategies and incentives to encourage the use of green propulsion will also be highlighted, as will the regulatory environment around it. This study intends to add to the current knowledge on sustainable transportation by offering a thorough review of green propulsion systems. It also hopes to give researchers, politicians, and industry stakeholders useful insights into how to promote environmentally friendly propulsion technologies.

Objectives:

1. To examine the different types of green propulsion systems, including electric propulsion, hydrogen fuel cells, biofuels, and solar propulsion, and understand their working principles and applications.

2. To analyse the environmental impact of green propulsion systems, including their potential to reduce greenhouse gas emissions and air pollution compared to traditional propulsion systems.

Methodology:

Conduct a comprehensive review of existing literature on green propulsion systems to understand their types, working principles, environmental benefits, and technological challenges. Analyse government policies and incentives aimed at promoting the adoption of green propulsion systems to understand the regulatory environment surrounding these technologies. Provide an outlook on the future of green propulsion systems, including potential advancements in technology, market trends, and their role in achieving sustainability goals.

Literature Review: Understanding Green Propulsion

"Green propulsion" refers to propulsion methods that cause little or no harm to the natural world. To aid in sustainable development and environmental preservation, these systems are engineered to lessen emissions, employ renewable energy sources, or enhance fuel economy.
When talking about transportation, "green propulsion" means using propulsion methods that don't harm the environment. According to Green et al. (2020), these systems aim to lessen the impact on the environment by cutting down on pollutants and greenhouse gas emissions, increasing the usage of renewable energy, and enhancing fuel economy.
The possibility for green propulsion systems to lessen transportation's reliance on fossil fuels and emissions of greenhouse gases has made them a hot topic in recent years. Covering the several forms of green propulsion as well as their effects on the environment, technical obstacles, and potential solutions, this literature review summarises the current state of the field.

Types of Green Propulsion Systems

Battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) are examples of electric propulsion technologies that have recently grown in popularity as substitutes for cars powered by internal combustion engines. While PHEVs use a combination of an internal combustion engine, an electric motor, and a battery to power their operations, BEVs rely only on electric motors powered by rechargeable batteries. In comparison to traditional cars, these emit no harmful gases from their tailpipes and can drastically cut down on emissions of greenhouse gases [1].

Fleets of hydrogen fuel cell vehicles (FCVs) generate power from hydrogen fuel cells, releasing only steam and water vapour as waste products. For longer trips, an FCV is the way to choose because of its greater range and faster refuelling periods compared to a BEV. One obstacle to its broad use, nevertheless, is the expensive infrastructure needed to produce and distribute hydrogen [2].

Biodiesel and ethanol are two examples of biofuels that come from sustainable sources like plant biomass or organic waste. With some tweaks, these fuels can be used in today's internal combustion engines, which means fewer emissions from cars and other transportation-related pollutants. Some worry that biofuel production will have an effect on land usage and food security [3].

Solar propulsion systems use photovoltaic cells or solar thermal systems to convert sunlight into usable energy for vehicles. Particularly in areas that receive an abundance of sunshine, solar-powered vehicles provide a renewable and sustainable energy option. Research on solar propulsion systems for transportation purposes is ongoing, nevertheless, about their efficiency and viability [4].

Environmental Impact of Green Propulsion Systems

Studies have shown that green propulsion systems have the potential to significantly reduce greenhouse gas emissions and air pollution from the transportation sector. A study by Borkowski et al. (2019) compared the environmental impact of electric vehicles (EVs) and internal combustion engine vehicles (ICEVs) in Poland and found that EVs had lower emissions of greenhouse gases and pollutants, such as nitrogen oxides and particulate matter [5].

Technological Challenges

Although green propulsion systems are better for the environment, there are a number of technical obstacles that prevent them from being widely used. Energy storage, developing infrastructure, and maintaining cost-effectiveness are all obstacles to overcome. To conquer these obstacles, technological advancements in battery production, hydrogen generation, and biofuel processing are required [6].

The continuous research and development efforts aimed at enhancing technology and decreasing costs bode well for the future of environmentally friendly propulsion systems. In an effort to lessen their impact on the environment and slow the rate of climate change, more and more governments and businesses are turning to green propulsion systems. To solve technological problems and make sure these systems last, nevertheless, more study is required [7].

Environmental impact of green propulsion

Analyzing the environmental impact of green propulsion systems is crucial for understanding their potential to reduce greenhouse gas emissions and air pollution compared to traditional propulsion systems. Green propulsion systems, such as electric vehicles (EVs), hydrogen fuel cells, and biofuels, have been developed as alternatives to traditional internal combustion engine vehicles (ICEVs) to mitigate the environmental impact of transportation.

Electric Vehicles (EVs): Petrol and diesel fuel are no longer necessary for EVs because they are propelled by electric motors and rechargeable batteries. Even when the emissions from power generation are taken into consideration, research has demonstrated that electric vehicles (EVs) still emit less greenhouse gases (CO2) than internal combustion engine vehicles (ICEVs). Compared to ICEVs, EVs require less energy when charging and can be powered by renewable energy sources, which further lessens their negative effect on the environment.

Hydrogen Fuel Cells: Hydrogen fuel cell vehicles (FCVs) generate power from hydrogen gas and release only heat and water vapour as waste products. Since hydrogen can be made from renewable resources, FCVs might drastically cut emissions of greenhouse gases in comparison to ICEVs. Hydrogen generation methods have varying impacts on the environment. The most popular process, steam methane reforming (SMR), is also the most carbon-intensive.

Biofuels: Plant biomass or organic waste are examples of sustainable organic materials that can be used to make biofuels. They can be retrofitted into current ICEVs with little work and contribute to transportation-related reductions in greenhouse gas emissions. Some biofuels have a larger carbon footprint than fossil fuels, while others have a smaller one; the environmental impact of biofuels is therefore dependent on the feedstock and manufacturing technique.

Comparative Analysis: Several studies have compared the environmental impact of green propulsion systems to traditional propulsion systems. For example, a study by Hawkins et al. (2013) found that EVs produce lower lifecycle greenhouse gas emissions compared to ICEVs, even when accounting for the emissions associated with battery production and electricity generation. Similarly, a study by Hooftman et al. (2017) found that FCVs have the potential to reduce greenhouse gas emissions compared to ICEVs, especially when hydrogen is produced from renewable sources.

Green propulsion systems have the potential to reduce greenhouse gas emissions and air pollution compared to traditional propulsion systems. However, their environmental impact depends on several factors, including the energy source used for electricity generation or hydrogen production, the feedstock and production process used for biofuels, and the lifecycle emissions associated with battery production for EVs. Further research is needed to fully understand the environmental impact of green propulsion systems and to ensure that they contribute to a more sustainable transportation sector.

Indian government schemes to support Green Propulsion

The Indian government has initiated several schemes and programs to promote green propulsion technologies and sustainable transportation. Some of the key schemes and support mechanisms include:

1. **FAME India Scheme:** Launched with the goal of increasing the country's adoption of electric and hybrid vehicles, the FAME India plan aims to accelerate the manufacturing and use of these types of vehicles. It encourages the purchase of EVs and helps fund the expansion of charging facilities.

2. **National Electric Mobility Mission Plan (NEMMP):** Through the promotion of hybrid and electric vehicles in India, NEMMP seeks to attain national fuel security. By 2020, the strategy aims to have 6-7 million electric and hybrid cars on the road, with a particular emphasis on two-wheelers and four-wheelers.

3. **Green Urban Transport Scheme (GUTS):** GUTS aims to promote sustainable urban transport by supporting the development of green propulsion technologies, such as electric buses and vehicles running on biofuels, in urban areas.

4. **Fiscal Incentives:** The government provides various fiscal incentives, such as lower import duties, reduced GST rates, and income tax benefits, to promote the adoption of electric vehicles and green propulsion technologies.

5. **National Biofuel Policy:** The National Biofuel Policy aims to promote the use of biofuels, such as ethanol and biodiesel, to reduce the country's dependence on fossil fuels and promote sustainable transportation.

6. **Research and Development Support:** The government provides support for research and development in the field of green propulsion technologies through programs such as the Technology Development and Demonstration Program of the Department of Science and Technology (DST) and the Technology Development Board (TDB).

These schemes and initiatives demonstrate the Indian government's commitment to promoting green propulsion technologies and sustainable transportation in the country.

Implication of the study

The analysis of the environmental impact of green propulsion systems reveals promising prospects for reducing greenhouse gas emissions and air pollution compared to traditional propulsion systems. Green propulsion technologies, such as electric vehicles (EVs), hydrogen fuel cells, and biofuels, have demonstrated significant potential to mitigate the environmental impact of transportation. EVs, powered by rechargeable batteries, produce lower emissions and can be charged using renewable energy sources, further reducing their environmental footprint. Hydrogen fuel cells offer zero-emission driving with only water vapor as a byproduct, though challenges remain in hydrogen production methods. Biofuels, derived from renewable organic materials, can be used in existing internal combustion engines with minor modifications, offering a viable alternative to fossil fuels. Comparative studies have shown that these green propulsion systems have lower lifecycle greenhouse gas emissions compared to traditional propulsion systems, contributing to improved air quality and reduced dependence on imported fossil fuels. However, the widespread adoption of green propulsion systems requires significant investment in infrastructure development, technological innovation, and policy support. Collaboration between governments, industry stakeholders, and researchers is crucial to overcoming these challenges and accelerating the transition to a more sustainable transportation sector.

Conclusion

In conclusion, the study on understanding green propulsion systems has provided valuable insights into the potential of these technologies to reduce greenhouse gas emissions and air pollution compared to traditional propulsion systems. Electric vehicles, hydrogen fuel cells, and biofuels offer viable alternatives for achieving sustainable transportation and mitigating the environmental impact of the transportation sector. While challenges such as infrastructure development, technological innovation, and policy support remain, the benefits of adopting green propulsion systems are clear. Continued research and development, along with collaboration between governments, industry stakeholders, and researchers, are essential to overcoming these challenges and accelerating the transition to a more sustainable transportation sector. By promoting the adoption of green propulsion systems, we can work towards a cleaner, greener future for generations to come.

References

[1] U.S. Department of Energy. (2020). Electric Vehicle Basics. https://afdc.energy.gov/vehicles/electric_basics_ev.html
[2] National Renewable Energy Laboratory. (2021). Hydrogen Fuel Basics. https://www.nrel.gov/hydrogen/fuel-basics.html
[3] International Renewable Energy Agency. (2019). Biofuels. https://www.irena.org/biofuels
[4] Solar Energy Industries Association. (2021). Solar Energy Basics. https://www.seia.org/initiatives/solar-energy-basics
[5] Borkowski, P., et al. (2019). Comparative Life Cycle Assessment of Electric Vehicles in Poland. Sustainability, 11(23), 6850. https://doi.org/10.3390/su11236850
[6] European Environment Agency. (2018). Electric Vehicles from Life Cycle and Circular Economy Perspectives.
[7] International Energy Agency. (2021). Global EV Outlook 2021. https://www.iea.org/reports/global-ev-outlook-2021