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Application of Hydrogen for Electric Vehicle

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A B S T R A C T

The energy management strategy is essential in systems that employ both fuel cells and batteries. It is mostly focused on enhancing one specific control target (ex: Hydrogen consumption). The main goal is to persuade more researchers and engineers who are working on fuel cell hybrid vehicles (FCHVs) to employ the cutting-edge, potent technology. The rising environmental need to slow down climate change necessitates more advancements in renewable energy. Fuel cell hybrid electric vehicles are appropriate for high energy applications .The creation of fuel cell hybrid electric vehicles is now hampered by several technological issues, such as adjustments to power sources, power electronic configurations, and control strategies. The appropriate size of the hybrid energy storage system is determined in this study by taking into account the energy management technique based on frequency separation. The world's sustainable fuel of the future, hydrogen, has the potential to displace fossil fuels and cut pollution emissions from the transportation industry. By evaluating recent developments in hydrogen-based transportation engines, this paper investigates the plausibility of utilising hydrogen as a significant fuel in the future. Internal combustion engines fuelled by hydrogen have inadequate power output and only 20–25% of the efficiency of internal combustion engines driven by fossil fuels. Recently, hydrogen-based internal combustion engines have drawn as much attention as they possibly could. This sentence provides a summary of the existing literature on the usage of hydrogen fuel cells in electric cars.

Keywords:Fuel cell, hybrid vehicle, energy management technique, batteries.

1. Introduction

Recent developments in fuel-cell technology have generated a lot of attention because of its advantages, such as zero increase in emissions from fuel cell electric vehicles (FCEV) innovation. Due to the strain of climate change and environmental pollution, fuel electric cars (EVs) have gained increased attention as an eco-friendly mode of transportation. EVs do not create any emissions when in motion, despite the fact that using additional fossil fuels to meet EVs' growing need for energy might indirectly raise emissions in the electrical system. Even though battery electric vehicles (BEVs) are becoming more and more common, there are still certain restrictions. This has a shorter driving range than HEVs and requires more infrastructure for charging. There are several fuel cell electric car combinations available.either fuel cell-powered battery electric vehicles (BEVs) or fuel cell hybrid electric vehicles with range extension (FCHEVs).

There has been a lot of interest in green transportation, and FCVs fueled by hydrogen are also known as. as water can now be electrolyzed using renewable energy to produce hydrogen. For the following reasons, FCVs are currently less common than EVs: First, the cost of producing hydrogen and fuel cells is now relatively high. It is the biggest obstacle keeping FCVs from being widely used. The issue with the investment in hydrogen refuelling stations comes in second. Due to the restricted supply of hydrogen filling stations, FCV owners have difficulties. Thirdly, FCV development is slower than that of EVs. Another difficulty is figuring out how to take first mover (EVs) market share in the future. The public is concerned about hydrogen storage, which is not the least of these safety worries. Hydrogen storage is one of the major research goals for the development of FCVs. Hydrogen storage systems are now being created in order to suggest new ways to meet client demands. In order to offer new methods to satisfy client demands, hydrogen storage technologies are currently being developed.

Hydrogen, which is now undergoing fast development, will be the ultimate source of energy for mankind in the future. Additionally, the fuel cell is one of the most well-liked sources of hydrogen energy and has attracted a lot of attention and study worldwide. Fuel cells are widely utilised in distributed generation, aviation, and transportation because to their high efficiency, high energy density, and absence of pollutants. The fuel cell automobile has notably shown off its major benefits and development potentials in the field of electric cars when coupled with energy storage devices to form a hybrid system. Research on fuel cell hybrid vehicles focuses on methods for managing energy, methods for matching parameters, and hybrid system modelling, with the latter being the major topic of this article. The energy management technique has a significant positive impact on the fuel cell hybrid system because it evenly distributes the required power across fuel cells and other power sources, improving system efficiency and lowering hydrogen consumption.

2. Methodology

Despite being less efficient than electric batteries, today's hydrogen fuel cells outperform internal combustion engine technology, which converts fuel into kinetic energy at a rate of roughly 25%. In contrast, a fuel cell may produce energy with an efficiency of up to 60% by combining hydrogen and air. Most individuals who keep up with current events are probably aware of the shifting transportation trend toward electric cars, and many have undoubtedly heard of Tesla. One alternative is hydrogen technology, albeit occasionally Due of the intensity, it could be challenging to recall them. The idea of replacing our present hydrocarbon-based infrastructure with hydrogen in order to lower carbon and carbon dioxide emissions is known as the "hydrogeneconomy." This covers a wide range of mobility usage in addition to fixed power generation. This transformation can occur anyplace that hydrocarbons are used as fuel, but prospective transportation applications are of particular interest as fuel cell electric vehicles (FCEVs) are considered as a highly competitive substitute for traditional hydrocarbon-powered cars.

Inside the fuel:

Similar to an electric battery, a fuel cell converts chemical energy into electrical energy by producing current through the flow of charged hydrogen ions over an electrolyte membrane. The sole emission from a fuel cell, other from heated air, is water, which is created when the fuel cells recombine with oxygen. Because they operate and act like ordinary cars, refuelling quickly at gas stations, and travelling between 500 and 600 kilometres on a single tank while emitting no hazardous emissions, FCEVs also provide very low entry hurdles in terms of cultural change.

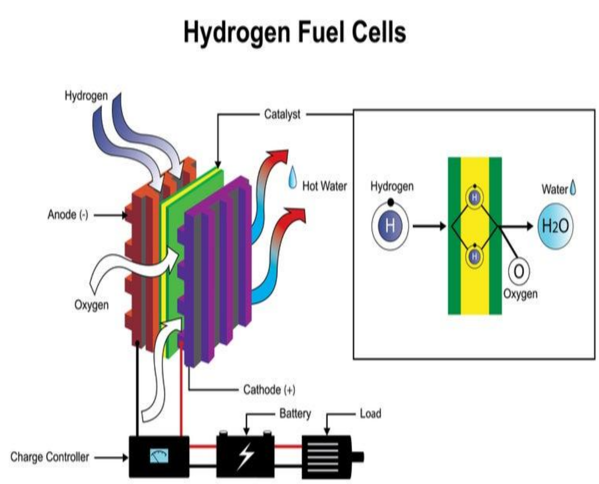

Figure 1.Hydrogen fuel cells

Making hydrogen:

With ever-increasing cost effectiveness, hydrogen fuel may be created by electrolyzing water and separating it into its constituent hydrogen and oxygen atoms. When fueled by renewable energy, this produces two useful gases and renders the creation of hydrogen carbon-neutral.

Only 2% of the 600 billion cubic metres of hydrogen produced annually worldwide, however, is now created by water electrolysis; the remaining 98% is produced from natural gas, with carbon dioxide as a byproduct. About 90% of this hydrogen's consumption goes toward making fertilisers or major petrochemical industries like oil, refining, and petrochemicals. The development of the hydrogen economy thus requires early government investment. Investments are required in the infrastructure for the production and distribution of hydrogen, in addition to the renewable energy projects required to offer carbon-neutral power. The absence of such infrastructure now represents the main obstacle to the adoption of hydrogen technology.

While hydrogen fuel cell electric cars (HFCEVs) offer a larger variety of uses, battery electric vehicles (BEVs) haveattracted greater public interest. Due to present storage and logistical issues, larger-scale commercial usage like heavy-duty transportation are typically more appropriate for hydrogen. Hydrogen fuel is readily available and produced efficiently via electrolysis using either petroleum waste product or energy from renewable sources. It may be swiftly refuelled and transported as a liquid or pressurised gas, bypassing the prolonged charge times required by today's batteries.

Hydrogen as a transporatation fuel:

The most fundamental kind of molecule, hydrogen is the fuel with the largest energy content by weight but the lowest energy content by volume. It occurs as a gas and a liquid in the atmosphere and in water. Due to its high energy content, hydrogen is used as a fuel in machinery like FCs and rockets. One of the primary problems of fossil fuels is that they produce dangerous pollutants, while hydrogen does not have this issue and has a heating value that is three times higher than that of petroleum. Given that it is a synthetic fuel, hydrogen is more expensive to manufacture and refine than oil.The development of an effective and sustainable technique for creating hydrogen as well as the use of hydrogen in engine applications have both been the subject of several studies. Fuel cell vehicles (FCVs) that operate on hydrogen are already being produced by automakers including Honda, Toyota, and Hyundai. Early adopters have mostly bought these FCVs, which are presently sold in North America, Asia, and Europe. The majority of consumers today, or early adopters, are highly educated people, families with high incomes, people with larger homes, people who are open to changing their way of life, and people with other characteristics that are similar.More than 6500 FCVs had been sold to customers as of June 2018. In part because the state has the greatest network of hydrogen refuelling stations in the world and automakers sell the cars there, California is the world's largest market for FCVs, accounting for more than 3000 of the 5233 vehicles sold globally. Several automakers are now promoting FCVs to consumers, which are commonly compared to BEVs. BEVs and FCVs both have electric motors, no emissions when stopped, and the option to use green and renewable energy sources as fuel. The driving range and the technique of refuelling are the two main distinctions between FCVs and BEVs. Better storage is one of the biggest obstacles to widespread hydrogen use.

Hydrogen is less dense than conventional fossil fuels, making it harder to store. Compression, cooling, or a combination of the two are necessary for hydrogen. Physical confinement is the best way to store hydrogen since it is practical and readily available, especially in pressurised tanks. While metal walled composites (Type III) are rarely utilised, all composites (Type IV) are widely employed. When the hydrogen has been pre-cooled, the filling time for these tanks is equivalent to that of fossil fuels. It is expensive to use compressed hydrogen (CH2) tanks on a large scale due to the high cost of materials andassembly.

Figure 2.zero emission transportation

A tank with an internal skeleton, which is a complicated design of struts under tension within the tank to resist the stresses of the compressed gas, is an alternative to conventional CH2 tanks that is currently being investigated. Liquid hydrogen (LH2) storage now offers the greatest specific mass (15%) of any automotive hydrogen storage method thanks to significant developments. Energy efficiency is decreased when liquid hydrogen is used. Boil off has to be addressed before LH2 systems are widely used. An alternate design is a cryo-compressed tank, where hydrogen is intensely compressed at cryogenic temperatures. More study is required to confirm the method's long-term feasibility and widespread adoption Hydride storage systems need to go through a lot of research and development to meet the requirements for large-scale use. Although NaAlH4 has drawn the most interest, it doesn't have the capacity needed for actual application. It is claimed that tanks without internal heat transfer systems might be constructed utilising the moderate heat of absorption from hydrogen, despite the fact that it is plentiful in the environment. However, hydrogen is not in its purest form. Water, hydrocarbon fuel, hydrogen sulphide, and other substances can all be used to make hydrogen.

Conclusion:

We come to the conclusion that the hydrogen-powered fuel cell electric car is the best and only way to simultaneously reduce greenhouse gas (GHG) emissions, local air pollution, and fossil fuel consumption, such as that of petroleum and natural gas (FCEV). The FCEV will assist us in achieving our objective of reducing our reliance on petroleum to the point where, with the exception of Venezuela, countries on the American continent could provide all of our oil requirements in an emergency. This will happen almost as rapidly as any other choice. Additionally, it has the lowest costs per car for infrastructure fuelling and urban air pollution.

The use of hydrogen technology may be superior to other options when it comes to addressing some of the key issues that modern societies are now facing. Fuels can be used directly in high-temperature fuel cells or converted into hydrogen for use in low-temperature fuel cells. Fuel cells that operate in reverse can be used to convert electricity into hydrogen. Therefore, switching between non-storable power and storable hydrogen is flexible.

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