A Review on Fuel Cell based Vehicle Design and Performance

Avanish Pandey, Umesh Chandra Verma
Mechanical Engineering Department
IET, Dr. RMLAU, Ayodhya (U.P.)

Abstract: Hydrogen fuel cell vehicles are similar to battery electric vehicles in that they use a high-voltage electric motor to propel the vehicle. Fuel cell vehicles are equipped with a hydrogen fuel tank and a fuel cell system that generates electric power to drive the electric motor. So fuel cell vehicles use on-board hydrogen stored in the fuel tank and refueled in minutes. In an fuel cell vehicle, an automotive fuel cell propulsion system runs the vehicle by converting hydrogen and oxygen into electrical current through an electro-chemical reaction in the fuel cell stack. It emits just water vapor and heat, without other tailpipe pollutants.

Keywords: Automobile, Fuel Cell, Hydrogen, Proton electrolyte membrane

1. Introduction:

Fuel cell vehicles are running on the pure hydrogen as zero emission vehicles hence fuel cell powered vehicles can be a longer solution to the environmental problems associate with transportation system. The design of vehicle is simple with respect to a direct storage system of hydrogen, but the refueling system should need to be developed. The storage system has potentially large influence on the driving the performance. So we are focusing on the hydrogen fuel cell powered vehicles. The concerns of efficiency with energy is important in many ways in fuel cell vehicles ,the efficiency of hydrogen use affects the fuel cost per mile; and also the efficiency of energy use also determine the total greenhouse gas emissions; and the overall efficiency of converting chemical energy into electrical energy at the wheels. These factors determine the output power or requirement of infrastructure and cost of for hydrogen production. In the coming section there will be discussion about the basic fuel cell vehicle and types of fuel cells and hydrogen storage option. The hydrogen involved is also not environmentally damaging for two reasons. First the pure hydrogen will be completely contained at all times during the process, and will not come in contact with the outside world .second even if any hydrogen does leak into atmosphere; it will immediately combine with atmospheric oxygen to form water. Hydrogen vehicles have the potential to revolute the transportation industry. So all multinational vehicle developers are investing significant funds in the development of hydrogen fuelled vehicles.

2. Related Work:

Indranil Ray et al ,(2013) In this time the demand of energy is increasing, so hydrogen could be in a major role as fuel, for the vehicles. Hydrogen can use as a transportation fuel, while neither nuclear energy nor solar energy can be used directly like hydrogen.. Hydrogen very important properties as transportation fuel, with a rapid burning speed, and high octane number, with no toxicity or ozone-forming potential. A hydrogen–air mixture has a low minimum ignition energy of 0.02 MJ. The combustion product of hydrogen is clean, in which it consists of water and a little amount of oxides of nitrogen (NOx). But main problem of using hydrogen as a transportation fuel is that its needed huge on-board storage tanks. A disadvantage is that the hydrogen needed an estimated 4 times much volume than the gasoline for store the energy. The storage of the hydrogen fuel is still not much standardized condition. In this review the different type of production techniques and storage systems of hydrogen can be used as IC engine fuel. Hydrogen should be used as alternate fuel of transportation so as to negate the concept for the greenhouse effect. The greenhouse gas emission reductions should be calculated on the annual basis. And the level from year to year varies significantly so this should be also specified . Hydrogen as a future energy source has a large number of advantages. One of hydrogen's primary advantage of hydrogen is that it can be produced from the different types of primary sources, and it will much likely be readily reachable almost anywhere in this world. Other main advantage of hydrogen in comparison to other fuels is that it's major oxidation product is water vapor, and its use produces no carbon di oxide . Hydrogen also help to reduce the carbon emissions, which produced from the renewable energy sources or by the nuclear energy. The hydrogen production by the fossil fuels causes the co production of carbon dioxide (CO2) and it is assumed to be mainly responsible for the so ''greenhouse effect''. These processes have been used the non-renewable energy sources for the production of hydrogen which are not sustainable. So renewable energy sources and related technologies for the hydrogen production will be needed in coming time. Hydrogen also has some properties as a IC engines fuels in automobiles. Hydrogen can be used as a fuel directly into the internal combustion engine is not much different from the engines used with the gasoline. The problem is that when hydrogen supplies three times the energy of gasoline it has only one tenth the density when the it is in a liquid form and then very much less when it is stored as compressed gas.

Liangfei Xu et al,(2013) A proton electrolyte membrane (PEM) fuel cell system and a Li-ion battery ,these are the two power sources in a fuel cell vehicle (FCV). The fuel cell system is component of the fuel cell stack and the subsystem for air or hydrogen supply and cooling the water. The operational procedure for the fuel cell system can be divided into several processes, as starting up, normal or abnormal working and shutting down conditions . In this review , a multi-mode real-time control strategy for a fuel cell powered vehicle has been proposed. The strategy is established on the basis of three typical processes which are (starting up, normal working and shutting down) the system of fuel cell , also the fuel economy and the system durability into the consideration. This strategy has been applied into a platform

vehicle for a 5-year project named as 'the next generation technologies of fuel cell city buses'. Experiment of the 'China city bus typical cycle' on a test bench for the bus were also been taken . The Result shows that the fuel economy is 7.6 kg (100 km) into the battery charge sustainable status. In a practical situation the total mileage of driving of more than 270 km could be achieved.

Kyle Simmons et al (2013), In that review it presents the modeling and supervisory energy management design for a hybrid fuel cell or battery-powered passenger bus. With the growing concerns of petroleum usage and also the greenhouse gas emissions in transportation sector, to find out the alternative methods for vehicle propulsion is needed. Proton Exchange Membrane (PEM) fuel cell systems have good possibilities for energy converters because of their high efficiency and zero emissions. It has been described that the benefits of Proton exchange membrane fuel cell systems can greatly improved by hybridization technique . In this review the challenges for developing the on-board energy management strategy with the near optimal performance has been described by a two-step process. First is that an optimal control based on the Pontryagin's Minimum Principle (PMP) has implemented to find out the global optimal solution that can minimize the fuel consumption for the different drive cycles, with or without grade. Optimal solutions have been the analyzed in order to aid in development of a practical controller is suitable for thje on-board implementation, it is in the form of an Auto Regressive Moving Average (ARMA) regulator. The results through Simulation shows that the ARMA controller is much capable for achieving the fuel economy within 3% of PMP controller, while its being able to limit the momentary demand of the fuel cell system

Søren Juhl Andreasen et al (2013) In this work it represents the concept of the electrical traction power system through a high temperature with the polymer electrolyte membrane fuel cell range extender which is usable for the automotive electrical vehicles. The concept of hybrid system has been taken ,it consist of a power system in which the primary power has delivered through a lithium ion battery pack. For increasing the running time of the application is connected with this battery pack and a high temperature PEM fuel cell stack (HTPEM)which has been taken act as an on-board charger and it is able to charge the vehicle during the operation in a hybrid series. Just because of the high tolerance to the carbon monoxide, high temperature PEM fuel cell system can be used efficiently a liquid methanol or water mixture of the ratio of 60%/40% by its volume as a fuel instead of the compressible hydrogen and enabling potentially with the high volumetric energy density. For the test of the performance of such a system like that the experimental validation conducted use a downsize version of the battery pack which was used in Mitsubishi and it is subjected to power cycles comes through the simulations of the vehicle undergone in multiple New European Drive Cycle. The concept behind the using of a high temperature PEM fuel cell system fuelled with the steam reformation of methanol as the range extender in the electrical vehicle being analyzed through the experiment which are performed in this work on the hybrid electrical system using with simulation based on the New European Drive Cycle is a vehicle simulation model. In the absence of regenerative breaking that potentially also is available for increasing the running time of the battery pack during the drive cycle the fuel cell act like the efficient and stable range extender , slightly increases the running time and range of power system. Depending upon the actual driving profile of the vehicle in question to for balancing between the battery and the fuel cell power can be optimized easily This work has been done in experimental basis which demonstrated the use of the liquid cooled high temperature PEM fuel cell stack in the hybrid electrical system which is usable in vehicle applications

Hui Liu et al. (2012) The 'Economy of Hydrogen ' is the proposed system in which hydrogen production has been done from the sources of carbon dioxide free energy and it is used as an alternate fuel for the transportation. The utilization of hydrogen for powering the fuel cell vehicles (FCV) can decrease the air pollutants and the greenhouse gases emitted through the transportation sector. To build the future hydrogen economy a significant development in the hydrogen Infrastructure must be needed and large investments also be needed for developing of production of hydrogen , storage systems , and distribution technologies .In this review it main focus is on the analytical approach of hydrogen demands from the hydrogen powered fuel cell vehicles in Ontario (Canada) and also the cost of hydrogen. Three p hydrogen potential demand scenarios over the long period of time has projected to estimate the hydrogen fuel cell vehicle's market penetration, and cost associated with the production of hydrogen storage and distribution also been calculated. A sensitive analysis has been done for the investigation of the incertitude of some important parameters for the designing of a future hydrogen infrastructure. It has been found that cost of hydrogen is very sensitive then the electricity price but other factors like water price and also energy efficiency of electrolysis, and life of plant has insignificant impact on the total cost of hydrogen production

Rajesh K. Ahluwalia et al, (2003) according the basis of energy consumption, the fuel economy of hydrogen fuelled light duty vehicles has been projected to and it could 2.5–2.7 times then conventional gasoline internal combustion engine vehicles economy at the same platform With the less efficient but high power density of 0.6 volt per cell than the base case of 0.7 volt per cell at the rated power point the hydrogen powered fuel cell vehicles (HFCVs) are projected to offering the same amount of fuel economy multiplier essentially .The key for obtaining the high fuel economy as measuring on the standardized urban and highway drive schedule lies for maintaining high efficiency of the fuel cell system at the low load. For achieve this instead of a high performance fuel cell stack the lower parasitic losses in the air management system, turndown and part load efficiencies of the Compressor expander module) are very critical. For the equal energy content of the fuel the Hydrogen fueled fuel cell vehicles offers the potential fuel economy of the multipliers of 2.7 and 2.5 for a compact and mid size also with the sport utility vehicle . For the non-hybrid vehicle, the improvement of potential in a fuel economy over the standard ,urban and highway drives schedules and degrades only the design-point of the cell voltage is lower from 0.7 to 0.6V.So there is little incentive during the selection of a high cell voltage at the rated power point is given that cost and the size of a fuel cell powered vehicle ,like it is the very expensive component in the system of a fuel cell, increasing non-linearly with the increment in cell voltage. The power consumption of the air

management system shows the largest parasitic loss in the system of a fuel cell. For preserving the benefits of the efficiency of the fuel cell stack at the part load it is much needed to select the air management system which is capable to achieve a reasonable turndown and also can operate at reduced pressure at where the efficiencies of CEM components are normally low at part load . The compact mid-size and sport utility fuel-cell vehicles has been analyzed in the work will need 4.3, 5.1, and 6.4 kg respectively, of the recovered hydrogen on board storage for achieving a driving range of 320 miles between the refueling (which is based on the fuel economy over the US Federal Urban and the Highway Driving Schedules). Further gains in the hydrogen fuel cell vehicles the fuel economies are much possible if their mass drag coefficient of drag, or the rolling friction coefficient can be reduced

Jenn Jiang Hwang et al, (2012) This Paper is a review on the current technology of the fuel cell scooters . The Fuel cell scooters by nature they have zero emissions in them, and they also have the potential for replacing the current internal combustion propelled engine scooters. First of all the fundamentals of fuel cells including with the critical technologies which are pertaining to the fuel cell engines and storage of hydrogen has been introduced. After that the technical feasibility which is used in the fuel cell scooters has been discussed in the parallel with the infrastructure model of hydrogen infrastructure . The whole completion of the fuel cell scooters was presented in Taiwan . however, the contribution for the replacement of the petrol scooters by hydrogen fuel cell scooters is for the reduction in greenhouse gas (GHG) emission and energy conservation of energy was calculated .Furthermore competition of industries with regarding to the development of fuel cell scooters has been discussed on the basis of a strengths weakness, opportunities, and the threats (SWOT) analysis. In conclusion with the mature technology of the fuel cell together with the solid foundation of the scooter industry. Taiwan offering the conditions that those were conducive for the development of fuel cell powered scooters. I social and technical capability of fuel cell will proved on a account of the leading demonstrations of the fuel cell powered scooters in the world. If a successful business model can develop , the whole will be able to enjoy the advantages of tapping with the large global market for zero-emission vehicles.

Ibrahim Dincer et al, (2011) The contribution for sustainability of hydrogen and the fuel cell systems has been described with the intention to provide a important understand the role of hydrogen which is expected to play in the sustainable energy systems. The demonstration the what are the benefits and also the sustainability attributes of hydrogen systems can be observed using the thermodynamics, assessment of life cycle and other different methods and it can be said that the hydrogen fuel cell systems can play a vital role, mainly by facilitate by using of renewable energy and by increasing the efficiency. The useful thing of the exergy method for the enhancement of efficiency and sustainability of the hydrogen energy systems .The main advantage of hydrogen energy and the fuel cell systems in to mitigate the environmental impacts, included the climate change, is also highlighted throughout. Two illustrations were presented in which one is covering the efficiency assessment of a Proton exchange membrane (PEM) fuel cell, and the second one is for a life cycle assessment to the fuel cell powered vehicles. The maximum consumption of energy for the internal combustion engine vehicle (ICE) is the usage stage. Energy consumption in the PEM fuel cell powered vehicles in use is smaller many times.. On the basis of a life cycle , consumption of energy and the emissions of the green house gases for the PEM fuel cell are lesser than the half in comparison for the internal combustion engine vehicle. Depending upon on the resource of hydrogen these results can be vary .It is expected that these results will be very useful for the scientists ,researcher scholars and engineering fellows and also for the policy and decision makers

Yongling Sun et al, (2010) In This work it is employed for the social lifetime cost for the evaluation of hydrogen fuel cell powered vehicles (HFCVs) from a social welfare perspective in the comparison of the conventional gasoline vehicles. In this a learning-curve model for the fuel cell system cost estimation over the time is employed . The delivery fuel cost of hydrogen fuel is estimated by using the hydrogen supply pathway model named DAVID SSCHISM, and vehicle costs of the most vehicle have been estimated by using the Advanced Vehicle Cost and Energy Use Model. For the estimation of external cost, the use of Advanced Vehicle Cost model and the Lifecycle Emissions Model is being used .Here the hydrogen transition costs over a range of market penetration has been examined with external evaluations, assumptions in technology , and the price of oil. In that the results shows that however the difference of cost between the fuel cell powered vehicles and in the gasoline powered vehicles is in very large position in the initial , Fuel cell vehicles accordingly has become the lifetime cost competitive in comparison with gasoline vehicles because their production volume increasing, even when without accounting for there externalities. Higher evaluation of the externalities and high price of oil can reduce the buy down cost also (cumulative investment which needed to bring the hydrogen fuel cell vehicles for lifetime cost equality with the gasoline powered vehicles) by 10 billion US dollars relative to this reference.

Ayfer Veziroglu et al, (2010) Hydrogen powered fuel cell vehicles (HFCV) will play a vital role as a part for changing towards the energy system which is based on hydrogen . When it is combined with the right energy source then fuel cells have the highest potential of efficiency and lower potential emissions by any of the vehicular power source. As the result, extensive work for the development of hydrogen powered fuel cell vehicles is taking place. The main aim of this paper was to precise the research and development related work which has been taken place in the past few years on the cell technology of fuel cell powered vehicles, with the focusing on the economic as well as environmental concerns. It can be observe that the current efforts are divided into different parts. The performance of this technology, durability, and also the fuel cell technology cost should be improved continuously, and some of the fuel cells are currently ready for mounting on the vehicles and tested. The Environmental and economical assessment of the whole hydrogen supply chain, including the fuel cell end use, also being carried out in the group of researchers around the whole world. It can be said that currently that fuel cells needs at least five years more for testing and improvement before the

large scale of commercialization can begin. Economic and environmental analysis shows that the fuel cell powered vehicles will likely to be economically competitive and also environmentally benign. Although ,the transition in the transportation sector for the use of hydrogen fuel cell powered vehicles will represent one of the bigger steps toward the economy of hydrogen.

Greg Frenette et al, (2009) The experience of Ford Motor Company with the Fuel Cell powered Vehicle was technology began over ten years ago with the concept of P2000. The Development of this vehicle demonstrated the technological feasibility, and revealed the so many of the challenges for the commercialization of automotive fuel cell vehicles. In the year 2005, Ford Motor Company launched the Focus fuel cell powered vehicle in the partnership with the U.S. Department of Energy(D.O.E) and Fuel Cells Hydrogen and Fuel Cells Canada(HFCC) and with also with the help of Clean Energy Partnership (CEP). The fleet was tested according to the Federal Motor Vehicle Safety Standards and it was placed in the service for general on road usage. The following Focus fleet and Ford introduces the Fuel Cell Explorer in the year 2005 the Hydrogen999 in 2007 , and also the HySeries Edge (2007). Within every of those new vehicles, several type of forward looking technologies for the on-road demonstration and testing were implemented. Till date the fuel cell power trains of the company have logged over the 1 million miles, and accumulated over the 30,000 h of operations, propelled the fuel cell powered vehicle in excess the of 207 miles per hour and it achieved considerable milestones during the cold start, reduction of cost , and the thermodynamic efficiency. some other achievements including for the implementation of new automotive requirements and testing procedure, also the service and architectural standard unique to hydrogen fuel cell powered vehicles(HFCVs). A conversation it has been presented here which outline the above and also the other key factors in the development on automotive fuel cell technology of Ford. Accordingly inhibitors, for the path of development has been outlined. The suggestion from the state of the technology that the recent predictions of large market penetrated in the year 2010–2035 time period were more optimistic. Without the detrimental technological changes, availability considerations of material availability will alone prevent this. Unfortunately a big deal of unwarranted hype in the industry, and academic has been led for the perception that is widespread automotive application for the fuel cell technology is a near term certainty. The appearance of the technological, economical, and many of challenges make this (popular) also . Nevertheless the successes of Ford , till date leading it to remains committed for the development path of long term development that it began well over a years ago. Ford is believing that the fuel cell powered vehicles will become economically more viable and they will be the important contributors for the resolution of the global warming and also the air quality issues.

Sebastian Verhelst et al,(2009)The threat posed through the change in climate and the striving for the security of energy supplies are issue high on the political agenda this time days. Government are taking strategically plan in the motion for decreasing primary energy uses, and to take the carbon out from the fuels and facilitate for the modal shifting For. Taking a prominent place in these types of strategic plans is that use of hydrogen as a future energy source . Many of the manufacturers of automobile are now leasing the demonstrated vehicles to the consumers by using the hydrogen-fueled internal combustion engines as well as fuel cell powered vehicles(FCVs).Some Developing countries in particular manner are trying to go for the hydrogen fueled internal combustion engines (powering with the two and three wheelers vehicles as well as passenger cars and buses also) for decreasing the local pollution at the suitable cost. In this review it offers a comprehensive overview of the hydrogen guelded internal combustion engines. All the Topics that have been discussed including the fundamentals of the combustion process of hydrogen, and detailing on the different types of mixtures strategies of formation and their characteristics of emission, measuring for converting existing vehicles, some important features of hydrogen engines with a state of the art for increment in the power output and in efficiency during controlling the emissions and modeling.

Mikhail Granovskii et al (2005) according to the data published from the various types of sources from which are used to perform the economical and environmental comparisons of these four types of vehicles conventional vehicle , hybrid vehicle electric and hydrogen fuel cell powered . The production of vehicle and their utilization stages are also taken into the consideration. This comparison is mainly based on procedure which is mathematical, and it included the normalization of the economic indicators (vehicle price and the fuels during the life of vehicle and range of driving) and also the environmental indicators (as greenhouse gases and air pollution emission) and also the valuation of an optimal relationship between the different types of vehicles in the fleet is considered. According to that comparison the hybrid and the electric cars pointer the advantages over the different types. The economical efficiency and environmental impact of electric car is depends virtually on the sources of the electricity. If the electricity is coming from renewable energy sources then the electric car has an advantage in the comparison to the hybrid car . If electricity is coming through the fossil fuels the electric car will remain competitive only in the condition if the generation of electricity is on board .it can be sheen that, if the electricity has been generated with an amount efficiency of about 50 to 60% via a gas turbine engine which is connected with a higher capacity battery and with the electrical motor and then it will be more advantageous for the electric car. The Implementation in the fuel cell stack and membranes which are ion conductive into the gas turbine cycle permit the electricity generation for increasing at the above mentioned levels and then air pollution and emission will be decrease . So the main conclusion behind this is the electrical car with electricity generation when it is onboard represent a considerable and much feasible in the development of the more efficient and ecological vehicles which have the zero emissions.

Vinay Ananthachar et al,(2004) The Energy efficiency of energy , weight of the vehicle, range of driving, and fuel economy are compared among all the fuel cell powered vehicles (FCV) with the different type of storage of the fuel and battery powered electric vehicles (BEVs). The Three options for the storage of fuel are examined and it is also compare in order for evaluating which the most energy efficient option for storing the fuel in fuel cell powered

vehicles. Compressible hydrogen gas storage, storage of metal hydride, and the onboard reforming of methanol. Solar energy can be considered as the primary source for neutral comparison of efficiencies for the zero emission vehicles (ZEVs).Components efficiencies has been from the literature. The electric vehicle which is powered by the battery it has the higher efficiency of conversion from the solar energy for the driving range of 300 miles. Among all the fuel cell powered vehicles, the most efficient is that the vehicle with onboard compressed storage of hydrogen. The compressed gas fuel cell vehicle is also the leader in the four different categories like weight of the vehicle for the range given , range of driving for a given weight, the efficiency which is starting with the also fossil fuels, and miles per gallon equivalent on the highway and urban driving cycles.

Ibrahim Dincer et al, (2004) In this work paper the discussion about some important energetic, environmental friendly and sustainable issues and the vital role of hydrogen and technologies based on fuel cell is one of the good solution according to these issues. The plan for the commercialization in many industrial countries like (USA, Germany ,Canada Japan, etc.) for the fuel cell technologies have started through the identifying by the most likely early markets for hydrogen as an important energy source and the fuel cells as power production devices from micro to macro applications, and set the realistic near term and midterm goal for the selected market penetration. The plan outlines some major barriers for achieving the goals and recommends the activities for capitalizing the incentives and overcome the barriers of market. The review also represent the possible future of hydrogen energy utilizing patterns for the healthy environment and sustainable development, and show that how the thermodynamics through energy can be beneficially used for evaluating hydrogen and the fuel cell systems and their important role in sustainability. Throughout in this paper current and the future prospect regarding to the thermodynamics and sustainable development of hydrogen and fuel cell system is considered. The advantage of hydrogen and the fuel cell systems is described by using the principles of thermodynamics and life cycle assessment for evaluating their main roles in the sustainable development. These following including remarks, which will be useful for our scientists, research fellows and also engineers as well as the policy and decision makers, can be done from the study: Moving towards the sustainable development requires that the environmental problems will be solve. These type of problems covers a continuous growing range of water pollution, air pollution, pollutants, solid waste, degradation of ecosystems, and extend over the ever wide areas. • The sustainable development required a sustainable supply of the energy resources that in long term, is sustainable available the at suitable cost and which can be used for all the required tasks without any negative social impacts. Energy resources like wind, solar, hydropower and biomass are normally considered as renewable and therefore these are sustainable over the long time . The use of these type of resources in production of hydrogen will be a important factor in sustainable development. Assessment of the sustainability processes and systems and efforts for improving sustainability should based in a part upon principles of thermodynamics, and mainly the insights released by the energy analysis. For community to attain or try for attaining the sustainable development the effort should be devoted for developing hydrogen and the technologies of fuel cell. Utilization of renewable energy in hydrogen production can provide a good solution regarding to current environmental problems. Advance hydrogen and fuel cell technologies can provide environmental responsible alternatives for conventional energy systems, as well as more suppleness and centralization. For realizing the exergy, energy, economical and environmental advantage of hydrogen and fuel cell based technologies an integrated set of different activities should be conducted which includes research and development, assessment of technology, standard development and the technology transfer. These can be aimed by the improvement of efficiency, make the suitable for these technologies and other environmental energy currencies for more injurious things, and improvement of the performance and implementation the main characteristics of these type of technologies. As the result of comprehensive life cycle assessment of proton exchange membrane fuel cell vehicles are presented based on the data which is published is available in the literature. The two important characteristics, which is assessed are consumption of energy and greenhouse gas emissions (GHG) during the whole life cycle of the automobile. However the conventional internal combustion engine vehicle (ICEV) is also assessed which is based on the same characteristics to compare with the PEM fuel cell vehicle. The results will be very useful to scientists, researcher fellows and engineers as well as for the policy and decision makers. The case study which was presented on hydrogen and the fuel cell systems clearly describes the importance of hydrogen and fuel cell system and also show that this technology also can help for achieving the better and emission free environment.

3. Conclusion:

Hydrogen Fuel cell vehicles are currently being researched for their feasibility of widespread usage in automobiles and other forms of transportation. Many companies are working to develop technologies that might efficiently exploit the potential of hydrogen energy for. The attraction of using hydrogen as an energy currency is that, if hydrogen is prepared without using fossil fuel inputs, vehicle propulsion would not contribute to carbon dioxide emissions.

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