Environmental Friendliness And Availability of Hydrogen Transportation and Future Improvements

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Abstract. As civilization develops, so does society's reliance on the earth's resources. New forms of energy are being created in order to limit the usage of nonrenewable resources. The utilization of new, clean energy sources decreases not just reliance on nonrenewable resources, but also pollutant emissions. Hydrogen is a sustainable and environmentally friendly energy source. Hydrogen transport is one of the most important applications of hydrogen energy in civilization. This research compares the differences in energy usage and emissions between hydrogen and traditional transportation. It also exhibits the economic benefits of hydrogen transportation and the adoption of hydrogen transportation in many nations. The current problems of hydrogen transport are analyzed and suggestions for improvement are given. The significance of this paper is to demonstrate the characteristics of hydrogen transport itself and to improve and popularise the use of hydrogen transport in the context of real-life situations.

Keywords: Hydrogen transportation; Environmental friendiness; Improvments.

1. Introduction

As the world's total energy consumption continues to rise, more diverse green resources are needed to fill the gap in energy consumption while ensuring the green development of the environment and ensuring that the dual carbon target can be achieved with high quality. In the current global supply of new energy, hydrogen energy is an important component. Hydrogen may be employed as an efficient energy storage carrier with a variety of storage methods and usage forms, making it an ideal alternative for renewable energy storage on a big scale and over a long period of time. The energy density is a measurement of the amount of energy in a unit volume that also represents energy efficiency. The energy density of hydrogen is 143MJ/Kg. It is four times the price of coal, three and a half times the price of gas, and four times the price of natural gas [1]. Grey hydrogen, The combustion of fossil fuels produces a significant proportion of hydrogen, reaching 95% of the total, emitting substantial amounts of CO2. Although carbon capture, utilisation, and storage (CCUS) technology has a lower environmental effect than blue hydrogen, which is still derived from fossil fuels. Green hydrogen is the purest type of hydrogen energy, manufactured by electrolyzing water and powered by renewable energy sources such as solar energy [2]. Hydrogen energy storage can be acknowledged as an extension of chemical energy storage, with better performance in multiple aspects.

Hydrogen cars are an industry that uses hydrogen energy, which is more suited for sustainable development, energy conservation, and pollution reduction than regular petroleum vehicles. Hydrogen energy may be utilised to power an automobile or a hydrogen battery. Currently, there are two main technologies for hydrogen based new energy vehicles. One is hydrogen fuel cell (HFC), which is more mature and widely used. The other is hydrogen fueled internal combustion engine (H2ICE), which combines hydrogen-based technology with traditional technologies and has good stability. The main reasons for using hydrogen fuel cells in automobiles are as follows: High energy efficiency. Compared to the nitric oxide, nitrogen dioxide, carbon dioxide, and sulfur dioxide produced by traditional fossil energy vehicles during operation, hydrogen fuel cells generate no pollution emissions. When vehicles are running, electric motors replace engines, making them quieter to operate. Currently, electronic systems are used in various parts, with strong modular functionality, according to the rule of energy substitution for 50 years, hydrogen energy can meet the requirements

of being safer and more environmentally friendly. Developed industries that can meet the current large-scale production infrastructure have higher peak and partial load efficiency than traditional fuel internal combustion engines, unlike fossil fuels, and do not rely on rare raw materials [3].

Hydrogen vehicles have their own advantages in terms of reducing emissions and pollution. By the year 260, the International Energy Council forecasts that hydrogen will make up 2% of the use of motor fuels and 8% of the consumption of electric cars. Hydrogen will continue to be utilised mostly as a feedstock for the production of chemicals and petroleum in the long run, along with some use as a fuel (mainly for motor vehicles). Hydrogen is primarily used in the field of fuel cells, which are also anticipated to be the solution to the coming energy crisis. Hydrogen is a non-polluting energy source. Hydrogen fuel cells have been used effectively in aircraft applications since the 1960s, and their performance has improved with time. This is significantly more costly than gasoline and diesel engines [4]. As hydrogen vehicles gain popularity, more businesses and individuals will choose between hydrogen and fuel-powered vehicles. Hydrogen cars offer distinct benefits, but they also have drawbacks that cannot be overlooked due to a variety of variables. Hydrogen cars are a very promising technology on a global scale.

2. Characteristics and use of hydrogen vehicles

2.1. Energy consumption and emissions of hydrogen transportation compared with conventional transportation

Hydrogen energy, as a clean energy source, is an energy source in line with the concept of sustainable development, and hydrogen vehicles are more environmentally friendly than conventional fuel vehicles, producing zero tailpipe emissions. The energy conversion rate of automobiles must be considered during the overall design. Hydrogen energy has been developed for many years and can be fully applied in the automotive field. Currently, the energy conversion efficiency of hydrogen powered electric vehicles is higher than that of traditional petrochemical powered fuel vehicles, and hydrogen powered electric vehicles are more environmentally friendly and have no exhaust emissions issues. Analyzed the emissions and energy consumption of hydrogen vehicles compared to conventional vehicles and conducted a well-to-wheel (WTW) energy use and emissions analysis to compare hydrofluorocarbons (Toyota Mirai) to gasoline conventional ICEVs (Mazda3).

The WTW results demonstrated that an HFCEV exhibits 5%-33% lower WTW fossil-energy use and 15-45% lower WTW GHG emissions than a gasoline standard ICEV, even when powered by H2 via a fossil-based production pathway (through SMR of natural gas). The type of energy utilised to compress or liquefy the H2 has an impact on the WTW outcomes. Comparing this method to a standard ICEV powered by gasoline, GHG emissions are reduced by 15%. The power utilised for compression or liquefaction has a significant impact on WTW CAP emissions for HFCEVs. A HFCEV emits fewer CO and NOx emissions than a gasoline-powered conventional ICEV in the setting of the typical electricity generation mix for the future U.S. grid [5].

And as hydrogen vehicles, the emissions of cars using liquid hydrogen and gaseous hydrogen as the internal combustion engine are different, as the Ugurlu's experiment proves [6]. The authors have found that GH2 (Gas Hydrogen) powered FCVs are the best choice in terms of total emissions. On the other hand, LH2 (liquid hydrogen) powered diesel locomotives with spark ignition (diesel locomotives with spark ignition) are the worst choice for total emissions. In addition, LH2-powered FCVs have the lowest emissions of volatile organic compounds (VOC), CO and NOx. FCVs with GH2 drive have the lowest PM10, PM2.5, SOx and CO2 emissions. The GH2 Power SI ICEV has the worst CO emissions. SI ICEV has the highest value for VOC, NOx, PM10, PM2.5, SOx and CO2 emissions [6]. As shown in the cases above, hydrogen vehicles consume less energy and emit fewer pollutants overall than fuel vehicles, and therefore, they will cause less pollution to the environment, in line with the concept of sustainable development.

2.2. Cost comparison of hydrogen transportation and traditional transportation

At present, with the popularity of hydrogen vehicles, more and more people can accept hydrogen vehicles. However, there are some problems in the cost of hydrogen vehicles compared to fuel vehicles, which affects the usage of hydrogen vehicles.

Freight makes for 8–15% of the total traffic flow in EU cities [7]. Due to the fact that trucks burn diesel, which results in emissions of CO2, NOx, and particulate matter of 25%, 33%, and 50%, respectively [8]. In order to reduce pollution, hydrogen vehicles can be utilised in place of diesel vehicles, but this also causes economic issues. By a research of prices and policy, Jones et al. assessed the viability and competitiveness of choosing hydrogen vehicles as a mode of transportation [9].

Even after accounting for tax breaks and incentives for low-emission vehicles, this study concluded that diesel vehicles are still the most cost-effective alternative for business use in the UK, however battery electric vehicles (BEV) and hydrogen fuel cell vehicles (HFCV) also have some advantages. According to the calculation model, diesel automobiles typically have cheaper TCOs (Total Costs of Ownership) than fuel cell and electric vehicles. According to data, the main component in this respect is insurance, which accounts for an average of 64% of the cost of BEVs and HFCVs. Research revealed that the competitiveness of both BEVs and HFCVs was sensitive to mileage due to decreased operating costs. After yearly mileage exceeds 17,000 miles, BEVs typically outperform their diesel counterparts in terms of price. Competitiveness did for HFCVs. The use of low emission automobiles has been found to be greatly aided by congestion tolls. The effects of low emission charges, which are now exclusively levied against diesel vehicles that don't comply with Euro 3 emission requirements, were taken into account. The manufacture of hydrogen fuel from renewable power should therefore be promoted because existing market conditions require that it not be significantly more expensive than electricity produced using conventional methods [9].

The research results show that lowering the price of hydrogen to an average of 7.00 pounds per kilogram will make hybrid fuel cells and pure hydrogen vehicles competitive compared to diesel vehicles. Importance of capital expenditure on fuel cell vehicles, which have a workable capital subsidy that might increase the products' competitiveness, is also a novel implication of the analysis[9]. The above analysis shows that although diesel transport vans are still the main equipment for transporting goods in Europe, hydrogen vehicles still have their own advantages and more appropriate economic policies can drive the development of hydrogen vehicles.

2.3. Conditions of use for hydrogen powered vehicles

2.3.1 The differences between the hudrogen energy vehicles

The BEVs are particularly effective at turning grid energy into traction, which can be recovered while driving by applying regenerative braking. As a result of the size and expense of the batteries needed to power the vehicle and its energy requirements, BEVs frequently have a restricted range, which is a significant drawback. Also, the battery system's "refuelling" can take several hours as opposed to the few minutes it would with a traditional car (CV). In order to benefit from traditional and electric vehicles and reduce the gap between CV and pure electric vehicles, people are considering another option. Hydrogen is a chemical energy carrier with a higher energy density than most batteries and reaches 39.39 kWh/kg current. The internal combustion engine (ICE) converts the chemical energy of the fuel fed into the engine into rotating mechanical energy, directly equivalent to FC [10]. The generated rotational energy is then used to drive the vehicle or focused and converted into electrical energy via a generator. Through environmentally friendly processes, chemical energy in FC is immediately converted into electrical energy. FC works similar to combustion engines [11]. Combustion engines and fuel cells serve as energy sources for continuous operation, while batteries are used to power electrical components and are used up over time [12].

2.3.2 Acceptance of hydrogen vehicles by the general public

Different people have different levels of acceptance of hydrogen vehicles, and everyone has to go through the analysis of the background needed when considering purchase hydrogen vehicles. In

some developing countries, such as China, the number of people who can accept hydrogen vehicles is relatively small. The majority of people are still willing to buy fuel cars due to traditional influences. Despite the policy support, new energy vehicles such as hydrogen cars are still not popular. Because of the problem of facilities, hydrogen vehicles do not have an advantage in terms of price and ease of use. In some extreme weather areas, such as extremely cold areas, battery cars cannot be used at all because of the weather, or even if they can be used, they still consume high energy and do not play a role in environmental protection. Therefore, the use of hydrogen vehicles should take into account factors such as local economy and geography.

2.4. The use of hydrogen vehicles in different countries

2.4.1 The US

The US transportation sector is expected to achieve many goals in different applications. These objectives deal with issues including quality and accessibility, fuel sources, emissions reduction, modern mobility models, and safety and security. In a few select regions with hydrogen infrastructure, notably in California but also in some northern regions, FFCEVs can be rented and purchased. Costs of fuel cell systems have decreased by about 80% from 275/kW in the US in 2002 to 50/kW in the US as of 2016, while their durability has increased by four times. Less than 10% stack voltage derating has been experienced during more than 120,000 miles of field operation for fuel cell systems. Politics played an important role in the development of California's hydrogen station. In less than two years, the state has gone from having zero retail hydrogen stations to over 30, and its annual hydrogen distribution has increased from 27,400 kg in 2015 to 109,200 kg in 2016. There are 180 operational hydrogen stations outside of the US as of 2017, with 36 public hydrogen stations in the US, 33 of which are in California [13].

2.4.2 Germany

While Germany has reduced emissions significantly in the majority of economic sectors since 1990, there has been minimal improvement in the transport sector. The main causes of this are the rise in miles travelled, the continuous use of fossil fuels as the primary source of transportation, and the high average CO2 emissions of vehicles [14]. Commercial FCEVs have been produced in large quantities in Germany for a number of years; as of the end of 2019, there were approximately 17,000 passenger FCEVs worldwide and 500 on German roads. Although these figures are lower than for BEVs (5.1 million worldwide in 2018). In operation as of 2019, there are more than 400 hydrogen refuelling stations globally, with Germany's network comprising about 90 stations [14].

2.4.3 China

Statistics from the China Association of Vehicle Manufacturers show that nationwide sales of hydrogen fuel cell vehicles increased by 79% in 2019 to a total of 2,737. Medium-sized trucks and large and medium-sized buses make up the majority of the available vehicles. According to data from Beijing Hydrogen Fuel Cell Motor Engineering and Technology Research Center, between 2016 and 2019, 1,752 hydrogen fuel cell buses were operational throughout 18 provinces in China, with light buses predominating in Shanghai, group buses in Beijing, and buses in all other provinces. A total of 3,448 pieces of trucks, mostly medium-sized trucks 8 to 9 tonnes, have been sold. China will have the second-highest number of hydrogen fuel cell cars and the fourth-highest number of hydrogen recharging stations by the end of 2019. The core technologies for the whole chain of the hydrogen car industry do, however, now need to be enhanced. Technical barriers prevent hydrogen fuel from being stored, transported, or refilled, and there is a dearth of expertise with large-scale use[15].

2.5. The improvements of hydrogen vehicles

The great majority of hydrogen energy is now grey hydrogen, which is created by burning fossil fuels, and the process of manufacturing hydrogen emits carbon dioxide. Green hydrogen, on the other hand, is created in a non-polluting technique by electrolysis of water from renewable sources, although it is inefficient and costly. The current energy efficiency of hydrogen production by water

electrolysis is 70%, the efficiency of hydrogen storage and transport is 90%, and 40%-50% of the energy used to reconvert hydrogen into electricity is lost. Overall, the efficiency of water electrolysis to convert the hydrogen back into electricity is only 30% [16]. They do not even account for the losses in hydrogen cells. At the same time, the high cost of hydrogen generated by water electrolysis means that green hydrogen is seldom utilised as a hydrogen battery, and if the use of hydrogen cars is to be encouraged, the energy consumed during the initial preparation must be considered. The hydrogen fuel cell uses hydrogen and by combining electrons to generate electrical energy and the efficiency of it can reach 60%-80% [17]. Though it is much higher than internal combustion engine, it's not suitable for mass production. Thus, the hydrogen internal combustion engine is used more frequently. At the same time, in order to promote hydrogen vehicles, the government should deal with the problem of insufficient hydrogen refueling stations or insufficient supply of hydrogen vehicles.

2.6. Suggestion:

The tests and analysis shown above demonstrate the features of new energy cars and petroleum automobiles. In terms of pollutant emissions, hydrogen vehicles clearly outperform. Hydrogen vehicles help to minimize greenhouse gas emissions while decreasing dependency on fossil fuels. Hydrogen cars also offer an edge in terms of overall energy usage. When employed as long-distance freight trucks, hydrogen cars offer a substantial pricing advantage from an economic standpoint. The usage of hydrogen cars varies by nation, however, all countries promote the technology. However, hydrogen cars have their own drawbacks in terms of utilization, with concerns such as energy efficiency and hydrogen refueling stations s4 variables influencing usage rates. Governments should explore boosting the use of new energy transport, such as hydrogen transport, to minimize air pollution emissions and nonrenewable resource usage. Increase the proportion of hydrogen transport in overall transport volume. Encouraging and actively informing people about the hydrogen transportation business is one approach to do this. Individuals and companies will be able to better accept hydrogen transportation if proper facilitation policies, laws, and regulations are developed.

3. Conclusion

This article discusses the benefits of hydrogen cars as well as their present status of utilisation. In terms of minimizing air pollution, hydrogen vehicles provide distinct benefits for private automobiles. In addition, for hydrogen-powered cars, gaseous hydrogen emits fewer emissions than liquid hydrogen. People are more eager to adopt hydrogen transportation. In terms of energy efficiency, hydrogen cars still need to be improved, while acceptability of hydrogen transportation differs due to factors such as climate and convenience. New energy transport, such as hydrogen transport, is more widespread and convenient in wealthy nations, but in underdeveloped countries, different technologies and policies still need to be improved. The significance of this paper is to highlight the benefits and drawbacks of hydrogen transportation, to analyze the availability of hydrogen transportation through examples, to highlight the development of hydrogen transportation under various conditions, and to identify the parts of hydrogen transportation that need to be improved for future development. The limits of hydrogen cars at this time are mostly in terms of vehicle safety and hydrogen energy storage and transportation in the industry's upstream, however the industry is presently expanding well and the technological restrictions are progressively being solved. The need for hydrogen generation is due to the refueling of hydrogen-powered buses. Based on the vehicle hydrogen - electricity - structure coupling safety integrated management and interlocking control technology, real-time collection and monitoring of hydrogen system hydrogen concentration, temperature, high pressure, low pressure, the entire vehicle collision and insulation detection, smoke, and other states are possible. The creation of a hydrogen leakage alarm processing approach, a pipeline accidental rupture state emergency treatment strategy, a vehicle misfire and collision state emergency treatment strategy, and a leakage state emergency treatment strategy. The plan is to build a comprehensive hydrogen-electricity-structure safety mechanism to ensure that in the case of an

accident, the high-voltage power and hydrogen supply are turned off in time to improve the vehicle's safety. By enhancing hydrogen storage and transportation, energy efficiency and energy loss such as electricity may be minimized, making hydrogen transportation more favorable in terms of lowering energy consumption. People will be more motivated to select hydrogen vehicles if hydrogen mobility is more convenient than petroleum-fueled automobiles.

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