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Hydrogen as a Potential Fuel for the Shipping Industry

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ABSTRACT: Mobility is a socioeconomic concept, and the demand for it is only going to grow in importance in the foreseeable future. Clean, cost-effective, and ecologically acceptable modes of transportation should be used wherever possible. Hydrogen is an attractive synthetic energy source for the transportation industry because of its high gravimetric energy density and availability in combined form throughout the world. In contrast, its oxidation component somehow doesn't contribute to greenhouse emissions, enabling it a potential replacement to fossil fuels. Its economically practical electricity generated by sustainable resources, on-board collection to give a required driving range, employment of long-lasting types of energy, and the construction of infrastructures for its supply continue to be important challenges. Using hydrogen energy source presents a variety of environment related implications, which are covered in this article. Recent developments in the manufacturing, transport, administration, and transport of hydrogen also are mentioned. This study finds that nonrenewable sources now dominate hydrogen manufacturing processes; nevertheless, improvements and encouragement of the use of renewable sources for hydrogen production are required in order to make it completely sustainable.

KEYWORDS: Biofuel, Energy, Fossil Fuel, Hydrogen, Transportation.

I. INTRODUCTION

The availability of sufficient energy to satisfy increasing demand, as well as the associated environmental challenges, are two important issues that must be addressed in the twenty-first century. Primary energy production in the globe is expected to increase by 1.37 percent per year between 2012 and 2035 if current policies are followed. In 2012, global primary energy output is expected to exceed 13.371 billion metric tons of oil equivalent (BTOE). Carbon-free power generation capacity will need to be built at least 10 TW by 2050 to meet the world's expanding energy needs while also ensuring that our planet is safe. In the wake of a dramatic rise in international petroleum prices, the inherent character of fossil fuels, rising awareness, and problems about protecting the public health, the global community is searching for new energy sources and developing alternative energy sources. On the basis of current projections, global CO_2 emissions from energy will total 30.4 gigatonnes in 2010. (Gt) [1].

Global energy demand is being met by a large portion (around 65 percent) of the world's supply of solid and vapor fossil energy (such as oil and natural gas), with petroleum oil financial reporting for further than several of the country's primary energy supply and more than 92 % of public transit energy demand. Global fossil fuel consumption, on the other hand, is projected to increase rapidly before declining. Despite claims by some energy analysts that road vehicles consume nearly half of the world's oil supply, the International Energy Agency (IEA) reports that road transportation accounted for approximately 77 percent of global transport oil demand in 2010, with a predicted 39 percent share of biofuel, 3 % of diesel and 1% of electricity inside the transport industry. Global energy demand is expected to double or quadruple by 2050, with oil and gas stocks inadequate to meet the demand [2].

With the fast increase in the number of cars comes increased environmental concerns, such as exhaust pollution. Vehicles are responsible for almost one-seventh of global CO_2 emissions and nearly one-eighth of primary oil consumption. Particulate matter and ozone emissions from local air pollution, climate change, traffic congestion and land use are all major concerns, as are injuries and noise. Local air pollution, mostly from vehicle traffic, is becoming a significant issue for urban air quality, particularly in the world's expanding megacities, and is expected to get much worse in the future. It is estimated that the burning of fossil fuels contributes to a 31012 kg/year increase in carbon dioxide (CO_2) in the atmosphere, which is a major contribution to global warming [3].

The only problem is that a large part (about 98 percent) of the carbon dioxide (CO_2) on Earth is dissolved in ocean water, which poses a problem. The ocean water contains about 2 1012 kg C each year, which is a significant amount. Even as temperature of the water rises, the absorption of carbon dioxide drops by about 3% per degree Celsius increase in temperature. Increased carbon dioxide solubilization equilibrium in between atmosphere and oceans occurs as a result of increasing sea surface temperatures. As a result, the carbon dioxide flow into the ocean decreases and, as a result, the concentration of greenhouse gases in the atmosphere rises as a result of rising open sea surface temperatures.

There is an urgent need to develop energy-saving solutions for automobiles in order to meet the problems of increasing fuel consumption and the containment of emissions connected with road transportation.

Manufacturing and using more powerful automobiles, together with alternative fuels that are less harmful and more sustainable such as bio-ethanol, biodiesel, compressed natural gas (CNG), and hydrogen, are the most important measures. It is produced from animal fats, vegetable oils, and used cooking oil, all of which are rich in triglycerides, and is a petroleum-free alternative to petroleum-based diesel fuel. A significant amount of effort is being done across the globe to create liquid biofuels from Jatropha Curcas L (JCL), and vegetable oils that has attracted the attention of businesspeople and politicians, as well as developers of clean energy process development projects. The oil extracted from this crop may be turned into liquid biofuel in a short period of time. Aside from that, press cake and organic waste materials may also be digested to produce biogas, which can be used to power vehicles and heat homes. However, biofuels alone will not be sufficient to solve the twin challenge of satisfying increasing fuel demand in the transportation sector while also reducing emissions [4].

Compressed natural gas (CNG) stands additional substitute car fuel which is available in a number of nations. CNG, in comparison to other options such as hydrogen and electricity, provides the greatest decrease in CO2 emissions from engines, with a reduction of 20 to 25 percent. Hydrogen may be used in conjunction with compressed natural gas to decrease emissions even more. Alternatives to gasoline and diesel each have their own set of restrictions and drawbacks. According to popular belief, no alternative fuel should be as simple and inexpensive to create and manage as gasoline and diesel. Conversion losses in the manufacture of alternative fuels, regardless of the premise that gasoline as well as diesel may be created from crude products with higher efficiency, are typically far more. Apart from that, gaseous fuels need specialized treatment and a contemporary distribution and refilling infrastructure to be used effectively. The development of contemporary powertrain components, including as fuel tanks, engines, and batteries, is necessitated by the development of energy carriers like hydrogen and electricity [5].

On three counts, hydrogen seems to be the most promising of the possible solutions for transportation applications. These are the reduction of greenhouse gas (GHG) emissions, the improvement of energy efficiency, and the reduction of local air pollution. In the late 1990s, technological advancements in fuel cell technology were made, and hydrogen could be used in internal combustion engines without requiring significant capital expenditures. It is because of these improvements that hydrogen is becoming more popular, especially in the transportation sector. Because hydrogen is fully emission-free just at point of final usage, it is an ideal fuel, it completely removes all carbon dioxide (CO2) and air pollutant pollution produced by transportation. Additionally, since fuel cells have greater conversion efficiency than internal combustion engines, they may have a significant impact in this area.

It is widely accepted that hydrogen is a significant clean energy source in many countries, and the fuel cell is a key technique for meeting the energy needs of the stationary electricity sector, transportation, industrial production, and residences sectors on an environmentally sustainable basis, according to reports from the EU Parliament in 2003 and the US Environmental protection Agency in 2004. In the next sections, we'll cover hydrogen's applications, manufacturing techniques, and properties as a transportation fuel, as well as the environmental and public safety ramifications of its usage, packaging, and distribution of hydrogen fuel [6].

A. Hydrogen's Environmental Benefits

Hydrogen has the potential to decrease greenhouse gas emissions from power generation, transportation, and heating. The reason for this is because when hydrogen is created via electrolysis (the use of electricity to split water into hydrogen and oxygen), no pollutants are released into the environment. The shipping industry is the most well-known use of hydrogen today. Drivers of electric vehicles are often concerned about their vehicle's range and the amount of time it takes to recharge. Hydrogen-powered battery - powered electric cars solve all of these problems since they have a longer range, use less fuel, and need little to no modification. In addition, hydrogen may be used as an alternative fuel in residential buildings. It may be utilized in combination with fossil fuels or as a stand-alone energy source. It may be transported via the existing gas infrastructure, thus avoiding the additional grid expenses associated with greater heat electrification. Once produced, hydrogen has the potential to be used as a short- and long-term energy storage medium. Proponents assert that surplus renewable energy, such as that produced by the wind blowing at night, can be collected and stored in salt caverns or high-pressure tanks, and that hydrogen generated by this electricity can also be stored in high-pressure tanks or salt caverns. Proponents also assert that hydrogen generated by this electricity can be stored in high-pressure tanks or salt caverns [7].

B. Hydrogen Uses

Present-day research is focused on hydrogen applications in any area of human life, including industry, transportation and residential construction. Hydrogen is mostly utilized in petroleum refineries, the production of ammonia or fertilizer, and the refining of metals such as nickel, tungsten, molybdenum, copper, zinc, uranium, and lead, with approximately 60 million metric tonnes used annually throughout the world. There are several applications where using hydrogen energy, such as in automobiles, would have a good effect immediately on the environment in terms of reduced emissions and a better climate. In today's world, hydrogen is used in the following applications:

1. Ammonia production as well as the production of other nitrogenized fertilizers.
2. Refining and desulfurization of petroleum products.
3. Hazardous wastes hydrogenation is an option (dioxins, PCBs).
4. Chemical plants, food preparation, ethanol, methanol, and dimethyl ether (DME) synthesis, and alternative energy synthesis using the Fischer–Tropsch (FT) method are all examples of applications.

C. Synthesis of Gases into Liquids

In addition, the researchers released a short analysis on the worldwide usage of hydrogen in the production of ammonia, compounds, and photochemical reactions.

Ammonia manufacturing consumes 250 billion cubic meters (BCM) of hydrogen annually, after which additional chemical products, which need 65 BCM, and petrochemicals, which use 185 BCM, are produced. These three industries account for 50%, 13%, and 37% of total hydrogen consumption, respectively, and account for 50%, 13%, and 37% of total hydrogen consumption.

It is feasible to use hydrogen for a wide range of energy uses, including nonpolluting vehicle propulsion, home and office heating, and aviation fueling. Using hydrogen in city buses and mining machinery are just a couple of examples of mobility applications that have progressed to demonstration standards, the fact that it is used in household generators and major electrical production systems shows that it is safe and it could be used in stationary applications as well, which is encouraging. Hydrogen is a potential fuel that offers many advantages over conventional fuels. Significant and functional use, on the other hand, would very certainly require measures to guarantee sustainable transportation from maker to end user, as well as extra service, fueling stations, and a host of other new concepts and technology [8].

D. Transformation of A Generation

The need for energy in our country is rising all the time. Even if we improve our energy efficiency significantly, experts estimate that our energy consumption in 2050 would be 30-40 percent more than it is now. Increases of this magnitude are not uncommon. During the past 30 years, the global use of power has more than doubled. The transformation in the way we generate energy that is anticipated is unprecedented. Renewables are getting more cheap, and more than $2 trillion has been spent worldwide in renewables over the past decade, according to the World Bank. Yet, despite this, the proportion of our energy that originates from fossil fuels has stayed largely stable. Renewable power has increased from less than 1% of the overall energy mix in 1980 to slightly more than 1% now, according to the International Energy Agency. In contrast, fossil fuels have remained steadfastly at 81 percent of the primary energy mix for decades [9].

Existing low-carbon technologies must be scaled up at a much quicker rate; otherwise, population expansion will continue to outstrip investment in renewables, and fossil fuels will continue to be the dominant source of energy for most people. However, it is unrealistic to anticipate any more progress from inventions that have proved to be promising so far. IEA reports that just three out of twenty-six low-carbon research areas (solar PV and onshore wind, energy storage, and electric vehicles (EV)) are progressed and commercially feasible, citing the International Energy Agency.

It's unlikely that we'll be able to extract more value from these three technical areas than what has already been planned for them. The unpredictable nature of solar PV and onshore wind forces them to be utilized in conjunction with energy storage or other forms of electricity generation. Increasing demand for high-density batteries, which are used in both storage and electric vehicles, is generating concerns about the availability of the raw materials required to manufacture them to keep up with the rate of growth. According to Bloomberg New Energy Finance (BNEF), graphite consumption is projected to increase from 13,000 tonnes per year in 2015 to 852,000 tonnes per year in 2030, while lithium, cobalt, and manganese output are expected to increase by more than 100-fold. Because of this, supply chains and prices are being squeezed, and employees in these mines, who are often forced to work in terrible circumstances, are also feeling the pinch.

E. Hydrogen as a Transportation Fuel

In recent years, hydrogen has become a popular choice for transportation applications because it is considered a clean fuel, emitting only water at various levels of use; (b) it can be engendered using any supply of energy, with widely available wind power being the most alluring; and (c) it is cheap to manufacture. Non-corrosive and colorless, hydrogen is a gas that does not pose a health hazard to humans or the environment. Hydrogen is by far the most abundant element on earth and has the greatest basic energy level when contrasted to other popular fuels. The density of hydrogen is substantially lower than those of gasoline despite its higher electricity production of 120 MJ/kg, that is 2.75 times more than those of hydrocarbon fuels. With 2.6 times the mass of oil, hydrogen has twice the amount of heat or calorific capacity as gasoline, as per the International Energy Agency (IEA). In order to retain the same amount of power, however, it takes about four times the quantity of fuel. Hydrogen is favored over the other gaseous fuels for internal combustion (IC) engines because it enables vehicle manufacturers to utilize existing engine production facilities and since it is not notably different from those other gaseous fuels already used in IC engines. In fact, a combination of hydrogen and ethanol is often utilized as a replacement for renewable fuel in carbureted spark ignition engines.

As with an electric battery, a fuel cell transforms chemical energy into electrical energy by transporting charged hydrogen ions across an electrolyte membrane to generate current. In the presence of oxygen, they recombine to form water, which is the sole pollutant produced by a fuel cell, along with heated air. Fuel cells currently surpass internal combustion engine technology, which converts fuel into kinetic energy at a rate of about 25% of that of electric batteries. A fuel cell, on the other hand, can mix hydrogen and air to produce electricity at up to 60% efficiency, making it the most efficient kind of energy generation.

F. Hydrogen Transportation and Delivery

Hydrogen distribution is a critical component of a long-term hydrogen-based economic system. It necessitates the construction of infrastructure to carry hydrogen from its source to the dropper at a refueling station or static power generating facility. Hydrogen may be delivered through three different modes: trucks for cryogenic liquids, pressurized tube trailers, and compressed nitrogen pipelines, among others. It is possible to utilize a combination of these three options at various phases of the development of the hydrogen fuel market. Because demand is expected to be minimal during the introduction period, tubes should be utilized instead of liquid hydrogen storage, as this prevents the boil-off that may occur with liquid hydrogen storage. As the demand for hydrogen rises, hydrogen may be transported to areas with high demand by strategically laying pipes, necessitating the development of additional hydrogen generation capacity. Cryogenic tanker trucks, which can haul greater volumes than tube trailers, are ideal for meeting the demands of growing markets [10].

The following variables have a major effect on distribution costs: the scale of the system (the rate of hydrogen flow into the city), the number of stations, and the distance between stations. The use of trucks to carry hydrogen would play a part in a hydrogen economy, even if pipeline transportation is preferred for fuels. Trucks would be useful for delivering relatively modest quantities of hydrogen over shorter distances. Transporting pressurized or liquid hydrogen, on the other hand, is very inefficient due to the low density of gaseous hydrogen due to its low density. Pipeline transportation has limitations in terms of transmission range and corrosion resistance, despite its cheap cost. Most metals have a crystal structure that may be easily penetrated by hydrogen; Hydrogen pipelines, on the other hand, are designed to prevent issues like hydrogen embrittlement and corrosion. High-purity sterling silver piping with a recommended hardness of 80 HRB (Hardness Rockwell B) is excellent for metal pipes with temperatures up to 7000 psi (48MPa). The cost, energy consumption, and pollution associated with hydrogen routes that impact core plant processing are all affected by the method hydrogen is delivered to the central processing facility. It would be decided by geographical and commercial circumstances which distribution method would be the most cost-effective (e.g. city population and radius, population density, size and number of refueling stations and market penetration of fuel cell vehicles).

II. DISCUSSION

Recently, the idea of using hydrogen as a viable fuel has received a great deal of attention, thanks to the formation of a broad-based "advocacy alliance" composed of a diverse range of academic scholars, policymakers, industry representatives, and members of civil society organizations who are all committed to promoting the use of hydrogen as a clean and safe energy source. shift from a carbon-based economy to a hydrogen one is necessary, three major technological obstacles must be overcome at this time. Starting with the cost of effective and cheap hydrogen processing and transmission, it is necessary to reduce the cost of hydrogen processing and transmission by a significant amount in order to compete with alternative choices. Secondly, the development of novel hydrogen storage systems for automotive applications is necessary to ensure that electric cars can go a sufficient distance. Fuel cells as well as other hydrogen-based innovations must also be lowered in cost.

Hydrogen transportation and supply are primarily controlled by four factors: (a) the future expense of hydrogen, (b) the pace of development of various hydrogen technologies, (c) the likelihood of lengthy greenhouse gas emission reductions, as well as (d) the cost of alternative energy sources are indeed the main variables influencing the supply and distribution of hydrogen. With numerous social, technical, and environmental advantages, hydrogen has the potential to be used as a long-term sustainable fuel. It offers the potential to reduce long-term dependence on fossil fuels while also limiting carbon and climate emissions from the transportation sector. In order to comprehend the concept of socio-technical processes that occur with each contemporary technology development, it is necessary to have a thorough knowledge of social and cultural dynamics. In our mostly fossil-fuel-based energy system, transportation and mobility, as well as the home and its amenities, are all important topics to consider and debate. Automotive speed and range cannot be rapidly surpassed by future contemporary means of transportation in society, given current trends and technology in this area.

As a consequence of technical advancements, socio-cultural boundaries may be eliminated via the use of economic measures. Efforts to support a certain technical advancement may include the employment of public relations campaigns and other comparable approaches. It is necessary to identify and understand the barriers that may be found in everyday routines and rituals, social expectations and beliefs, aesthetic preferences, and other aspects of one's life. It is necessary to change the current energy system design and social activities, and it is also necessary to provide adequate political-administrative support in the form of public financing, public spending, and law.

III. CONCLUSION

Hydrogen is often cited as the most energy-efficient fuel for cars due to its high energy density. In terms of flexibility, it is on par with electricity, and it might well be generated from a combination of renewable as well as nonrenewable energy sources alike. Actually, non-renewable sources account for the vast majority of hydrogen generation; but, from a sustainability standpoint, it is essential that renewable sources such as sun, wind, and biomass account for the vast majority of hydrogen production. Ammonia processing, hydrogenation of hazardous wastes, desulphurization and hydro-cracking in petroleum refineries, amalgamation of ethanol and methanol, rocket fuel, and a variety of other uses are all made possible by the use of hydrogen in today's society. When it comes to transportation, one of the most promising future applications for both IC engines and fuel technology is that The use of alternative fuels has a variety of benefits over regularly used systems that rely on conventional fuels, including improved energy transfer efficiency and, in the example of fuel cells, nearly zero emissions. The market is well-versed in hydrogen, which contributes to the impression that it is a safe and environmentally friendly fuel. However, it must be thoroughly evaluated before it can be made available to the general public for use.

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