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Green Hydrogen: Fuel for Transportation

Transportation is the number one contributor to carbon dioxide emissions from human activities in our atmosphere [1]. The current conventional fuels that we are using for transportation are hydrocarbons. The combustion of these fuels produces carbon dioxide by design as well as other pollutants. Although carbon dioxide may seem like a harmless gas, large amounts produced from the transportation industry are upsetting the CO2 cycle and producing excess carbon dioxide which is a primary contributor to global warming. A major transition must take place over the next few years in order to prevent carbon dioxide emissions rising to the point of irreversible permanent global damage. Although reversing strategies like carbon capture have been discussed, the root-cause cannot be ignored. Green hydrogen could be the future for transportation fuel.

A new exciting potential alternative fuel for the transportation industry is pure hydrogen which can be utilized either through traditional combustion or as an input to an on-board fuel cell which in turn generates electricity which powers the vehicle. In both of these processes the emissions produced from the hydrogen fuel is pure water without any carbon dioxide which greatly reduces the environmental impact of operating the vehicle. While hydrogen as a fuel greatly reduces the emissions generated by the operation of a vehicle, it also important to consider the carbon emissions generated during the production of the hydrogen. There are 4 main types of hydrogen classified by their production method: brown hydrogen, grey hydrogen, blue hydrogen, and green hydrogen. Brown hydrogen is the worst environmentally, as it is created through the conversion of coal into hydrogen and carbon dioxide, where all of the carbon dioxide produced is emitted into the atmosphere, along with the other pollutants associated with coal. Brown hydrogen is primarily used in China, in the chemical and energy industries

and makes up approximately 28.4% of total hydrogen production worldwide, Grey Hydrogen is a cleaner fuel because it is produced by converting natural gas into hydrogen and carbon dioxide usually by way of steam methane reformer (SMR) units, however all the carbon dioxide produced by an SMR is also emitted into the atmosphere, similar to brown hydrogen. [4] Grey hydrogen is currently the most common hydrogen fuel produced, making up 71% of total hydrogen production worldwide. [4] Blue Hydrogen is a much cleaner alternative that is also produced by converting natural gas into hydrogen and carbon dioxide, but in this case the carbon dioxide is permanently stored or reused through carbon capture lowering carbon dioxide release to the atmosphere dramatically. This process is generally limited to geographical areas where carbon dioxide gas storage is possible (i.e. natural underground caverns or reservoirs under the ocean). Green hydrogen is by far the most environmentally friendly hydrogen fuel. Green hydrogen is made by splitting water into hydrogen and oxygen by electrolysis, where the electricity provided comes from renewable power sources.

Green hydrogen is typically produced through the electrolysis of pure water, where it is split into its two components hydrogen and oxygen. An electrolyser uses electricity generated from renewable sources to be generated, it consists of a power source, pumping system, separator, storage compartment, and ventilation. [3] The electrolysing process uses a cathode to attract the hydrogen gas and an anode to attract the oxygen gas. [3] Since this process uses renewable energy and only produces hydrogen and oxygen, virtually no carbon emissions are produced in the production of this fuel.

Green hydrogen is an important alternative fuel that can be a critical tool to lower carbon emissions generated by the transportation industry to combat further global warming. Green hydrogen fuel cell powered vehicles have been manufactured, tested, and demonstrated to be a viable alternative to gasoline powered vehicles. However, there are some major obstacles that need to be overcome in order to achieve wide scale adoption of the technology for transportation. One major obstacle is the lack of a safe, light weight and efficient onboard storage method for green hydrogen fuel in vehicles. The most commonly used method for hydrogen storage for fuel cell vehicles is compressed e gaseous state

hydrogen tanks that store the hydrogen at high pressures. Gaseous hydrogen has a much lower volumetric density than gasoline, so to achieve reasonable driving distances per fill from a hydrogen vehicle that uses a conventional metal compressed hydrogen tank requires relatively large, heavy, expensive tanks which negatively impacts the vehicle's design [5]. Further research and development work is required to find solutions to this critical onboard storage problem. One potential solution can include improved onboard compressed gas storage tanks using improved advanced materials of construction tp achieve safe, lighter weight tank designs. A second more advanced solution to investigate is the replacement of conventional gaseous hydrogen storage tanks with more advanced materials-based hydrogen storage technologies including sorbents, chemical hydrogen storage material, and metal hydrides.[5] This work is critical to allow green hydrogen to become a wide scale adopted fuel for transportation which will be an important method to prevent further global warming of our planet.

Green Hydrogen: The Future of Fuel

Green hydrogen is an environmentally friendly fuel, used to reduce the overall carbon emissions released from all conventional hydrocarbon fuel powered systems.

There are four types of hydrogen used for fuel, listed in the order from environmentally worst to best: brown hydrogen, grey hydrogen, blue hydrogen, and green hydrogen.

Brown hydrogen, the worst environmentally, is created through the conversion of coal into hydrogen and carbon dioxide. Grey hydrogen, the most common hydrogen fuel, is produced by converting natural gas into hydrogen and carbon dioxide, making it slightly better for the environment. Blue Hydrogen is a much cleaner alternative that is also produced by converting natural gas into hydrogen and carbon dioxide, but the carbon dioxide it stored or recycled. However, the production of green hydrogen produced no carbon dioxide emissions.

Green hydrogen is a fuel produced from water and renewable energy, where the fuel is pure hydrogen, and when it is used, either through combustion or fuel cell, it is released as H2O (water), leaving no harmful emissions or carbon dioxide.

Conveniently, hydrogen is the most common element available, so it will not run out from large amounts being used. [2] Green hydrogen is produced by water electrolysis, where it is taken from water and electricity from renewable sources divides it into its components, hydrogen and oxygen, releasing no carbon dioxide emissions.

Transportation is the number one contributor to carbon emissions in our atmosphere, making up 27% of the greenhouse gas emissions. [1] Green hydrogen powered cars, are fueled by hydrogen and produce only water as an emission.

Hydrogen can be transported under high pressure, in a liquid form, either through pipelines or in tanks by trucks. [2] This allows for distribution of the fuel to be easily accessible over large regions with fewer electrolyser plants.

Green hydrogen is important in the future of fuel for transportation and other industries contributing to large amounts of carbon dioxide emissions. If we can eliminate the primary source of carbon dioxide released, there can be a critical movement working towards eliminating the climate crisis.

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