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Original Research Paper

Energy

A REVIEW ON THE HYDROGEN AS A FUEL OF FUTURE

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ABSTRACT India has been ranked third largest primary energy consumer in the world. Over 80% of India's energy needs are met by three fuels: coal, oil and solid biomass. These are the non-renewable source of energy. When coal is burned to produce energy it releases several harmful gases that negatively affect the Earth and the Environment. So there is need of some such type of sources which don't affect the environment. This Research Paper giving a review about the better source of energy that is the Hydrogen Fuel and now it is viewed as a fuel of future .

KEYWORDS : Energy Source, Green Hydrogen, Fuel

INTRODUCTION:

Hydrogen fuel refers to hydrogen which is burned as fuel with oxygen. It is zero-carbon, provided that it is created in a process that does not involve carbon. It can be used in fuel cells or internal combustion engines . Hydrogen used in commercial fuel cell vehicles such as passenger cars. It is also used as a fuel for spacecraft propulsion and is being proposed for hydrogen-powered aircraft. Hydrogen is a potential paradigm shifter that can play a major role alongside battery electrification and renewable fuels in creating the carbon-neutral societies of tomorrow. Hydrogen is an energy carrier with qualities that can help reduce the net sum of greenhouse gas emissions. Because pure hydrogen does not occur naturally on Earth in large quantities, it usually requires a primary energy input to be produced on an industrial scale[1].Hydrogen fuel can be produced from methane or by electrolysis of water[2]. As of 2020, the majority of hydrogen is produced from fossil fuels by steam reforming or partial oxidation of methane and coal gasification with only a small quantity by other routes such as biomass gasification or electrolysis of water[3][4][5].

Types of Hydrogen

Hydrogen itself is a colourless gas but there are around nine colour codes to identify hydrogen including Green, Yellow, White, Black, Brown, Pink, Turquoise, Grey, and Blue hydrogen. The colours codes of hydrogen refer to the source or the process used to make hydrogen.

White hydrogen (Natural hydrogen)

In nature, hydrogen is most commonly found in different deposits in its gaseous form (H2). This is referred to as White hydrogen. There isn't a viable strategy to use and extract this hydrogen as of today. Instead, to utilize the power of hydrogen, different processes to generate it artificially need to be applied, which is what the different colour denominations represent.

Blue hydrogen

Blue hydrogen is produced in the same way as Grey hydrogen by SMR, but where excess CO2 is prevented from dispersing in the atmosphere using Carbon Capture and Storage (CCS). Blue hydrogen is often referred to as a carbon-neutral energy source.

Pink hydrogen

Pink hydrogen often refers to hydrogen that has been produced through the process of water electrolysis powered by nuclear energy. This is an interesting path for several countries and produces clean hydrogen.

Yellow hydrogen

Yellow hydrogen is one of the more confusing colours. It is used by some to refer to hydrogen that has been produced through the process of water electrolysis powered solely by solar power, while confusingly, others consider it as electrolyzed hydrogen made using the power of mixed sources (electricity mix) – e.g., solar, nuclear, bio, fossil among others. And in the US, Yellow is used for Nuclear only.

Brown and Black hydrogen (Coal hydrogen)

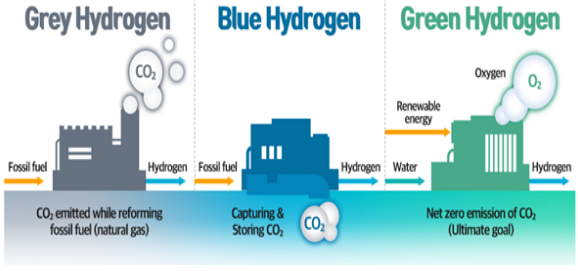
The oldest way to generate hydrogen is by transforming coal into hydrogen. This generates what is called either Brown or Black hydrogen. The hydrogen is dubbed as either Brown or Black depending on what coal is used:
Lignite coal -> Brown hydrogen
Bituminous coal -> Black hydrogen

Grey hydrogen

Grey hydrogen is hydrogen produced using SMR (Steam Methane Reforming) where excess CO2 is released into the atmosphere. It accounts for most of the production of hydrogen today.

Green hydrogen

The definition of the term "Green hydrogen" is twofold: Green hydrogen produced by electrolysis using renewable energy. This includes electrolysis with electricity coming from green sources such as solar, wind, and hydroelectric power. Thermo chemical water splitting in to the newest source of green hydrogen production beyond hydrolysis. Using chlorine and sulphur, in the presence of a nuclear reactor, sunlight can be focused above a solar thermo chemical hydrogen (STCH) reactor to produce hydrogen.[6].



Uses Of Hydrogen Fuel :

1. Primary Source of Renewable Energy-

Fuel cell - Hydrogen fuel can provide motive power for liquid-propellant rockets, cars, trucks, trains, boats and airplanes, portable fuel cell applications or stationary fuel cell applications, which can power an electric motor[7]. Hydrogen is considered as the primary sustainable source of renewable energy and is highly required for advanced energy conversion systems [8][9].

2. Global Distribution
Fuel cells boast both the range and power required for long-haul trucking and local distribution. Companies like Nikola, Hyundai, Toyota, Kenworth and UPS are already building hydrogen powered semi-trucks and vans.

3. Buses
Hydrogen power is being considered for other public transportation applications, including hydrogen fuel cell buses. Several major cities including Chicago, Vancouver, London, and Beijing have experimented with hydrogen powered buses.

4. Personal Vehicles
Nine of the major auto manufacturers are developing hydrogen fuel cell electric vehicles (HFCEVs) for personal use. Notable models include the Toyota Mirai, Honda Clarity, Hyundai Nexo, and BMW I Hydrogen Next.

5. Planes
Several experimental projects like the Pathfinder and Helios prototypes have explored application of hydrogen fuel cells in aerospace. These long-range unmanned vehicles utilized a hybrid system with hydrogen fuel cells which were replenished by electrical power from solar arrays, allowing for theoretically indefinite day and night continuous flight.

6. Backup Power Generation
At a local level, stationary fuel cells are used as part of uninterruptible power supply (UPS) systems, where continuous uptime is critical. Both hospitals and data centres are increasingly looking to hydrogen to meet their uninterruptible power supply needs. Recently, Microsoft made headlines with a successful test of its new hydrogen backup generators, running one data centre's servers on nothing but hydrogen for two days.

7. Mobile Power Generation
Hydrogen offers versatile options for mobile power generation. In fact, some of the earliest hydrogen fuel cells were developed by NASA to provide electricity for rockets and shuttles in space.

8. Unmanned Arial Vehicles (UAVs)
From package delivery to search and rescue operations, many new applications of UAVs (i.e. drones) are significantly limited by the power and range provided by traditional batteries. Both military and private industry plan to overcome these challenges with hydrogen fuel cells that boast up to three times the range of battery-based systems. Fuel cells also have a higher energy to mass ratio and can be refuelled in a few minutes.

Hydrogen as a fuel of future:
1. Zero emissions on the road- By the use of fossil fuel for energy transportation contribute approximate 25 percent of CO2 emission globally. Hydrogen powered vehicle can solve this problem because it emit only heat and water as by products.
2. Longer driving range - with a relatively short refuelling time vehicle with hydrogen fuel cells can also travel for longer on lesser energy.
3. Decarbonising industrial sector – the petrochemical and chemical sector which produced up to 1.25 gross tonnage of carbon emission is turning to electrolytic hydrogen as a substituent for hydrogen fuel.
4. Easy to store easy to use- – one key benefit of hydrogen is the ease at which it can be stored , shipped and used.
5. Successful use in space travel- use of hydrogen as a fuel is not new. Hydrogen was used by the NASA as a rocket propellant fuel cell unit. to operate auxiliary power units in space since the early 1960s. It means it can use in space travel easily.
6. Hydrogen application is the sustainable fuel for future.

Plan of India for green Hydrogen:
1. As India's growth story unfolds, its demand for energy and resources is set to rise. Energy use has doubled in the last 20 years and is likely to grow by at least another 25% by 2030. India currently imports over 40% of its primary energy requirements, worth over USD 90 billion every year. Major sectors like mobility and industrial production are dependent on imported fossil fuels. This necessitates shift towards technologies that enhanced renewable sources of the energy and progressively reduce the reliance on fossil fuels.

2. Green Hydrogen, produced using renewable energy, has the potential to play a key role in such low-carbon and self-reliant economic pathways.

3. As the global consensus towards Net Zero gathers momentum, the demand for Green Hydrogen and its derivatives is set to rise. The asymmetries in expected demand and production capabilities for Green Hydrogen, in different countries and regions, are likely to result in international trade of Green Hydrogen and its derivatives like Green Ammonia and Green Methanol. This presents a unique opportunity for India to capitalize on its abundant renewable energy and land resources and the growing global demand for Green Hydrogen, to become a leading producer and exporter of Green Hydrogen and its derivatives.

4. India has started the Mission is to make India the Global Hub for production, usage and export of Green Hydrogen and its derivatives. This will contribute to India's aim to become Aatmanirbhar (self-reliant) through clean energy and serve as an inspiration for the global Clean Energy Transition.

5. To achieve the above objectives, the Mission will build capabilities to produce at least 5 Million Metric Tonne (MMT) of Green Hydrogen per annum by 2030, with potential to reach 10 MMT per annum with growth of export markets. The Mission will support replacement of fossil fuels and fossil fuel based feedstock with renewable fuels and feedstock based on Green Hydrogen.

CONCLUSION:
Hydrogen is a potential paradigm shifter that can play a major role alongside battery electrification and renewable fuels in creating the carbon-neutral societies of tomorrow. Hydrogen is an energy carrier with qualities that can help reduce the net sum of greenhouse gas emissions.

Hydrogen can also be produced through the electrolysis of water, leaving nothing but oxygen as a by product. Electrolysis employs an electric current to split water into hydrogen and oxygen in an electrolyser. If the electricity is produced by renewable power, such as solar or wind, the resulting pollutant-free hydrogen is called *green hydrogen*. Green hydrogen is exciting," he said. "It's exciting because we can use it in every sector. It's exciting because it tackles the hardest parts of the problem—industry and heavy transportation. And so we can say that Hydrogen and particularly Green Hydrogen is the future fuel.

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