

Future Prospects for Hydrogen Fuel

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Introduction

Hydrogen represents a new source of clean energy, as it is considered a candidate to change the face of the energy industry because it does not produce any carbon emissions. The use of hydrogen as an alternative source of energy has become at the top of the attention of many countries recently, as it is one of the important sources of clean energy. This is due to its importance in reducing carbon emissions and limiting the phenomenon of climate change, as hydrogen can be used as a fuel in several sectors such as industry, utilities and transportation, which can be produced through several methods, and the most common methods today are natural gas reforming and electrolysis, and the methods include other processes that operate with biological processes and solar energy, and hydrogen energy is usually used to generate electricity or even as fuel in hybrid and electric cars.

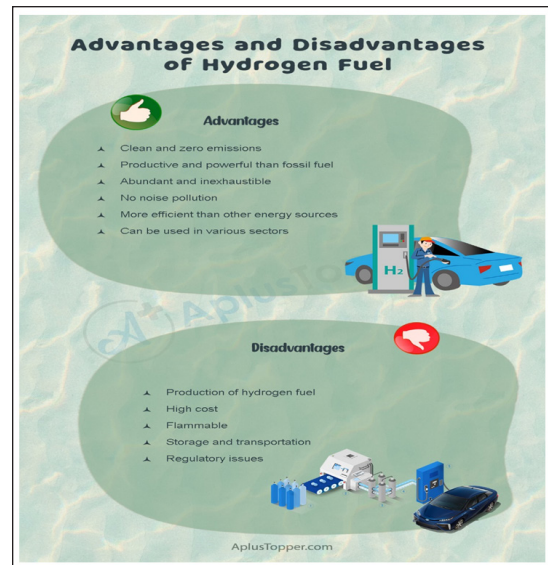
Hydrogen Fuel Energy

Hydrogen is considered one of the new energy alternatives, and it could be the fuel of the future because its combustion does not usually cause any environmental pollutants and because the heat content of its combustion is approximately three times the heat content of the same mass of petroleum fuel. In spacecraft, it is burned to propel jet engines. It can also be burned with oxygen in a combustion chamber, producing high heat that can turn water into steam to drive turbines to generate electrical power, in addition to the possibility of using it in internal combustion engines for cars. Like natural gas, it can be burned and the resulting heat used for heating.

Hydrogen Fuel Advantages and Disadvantages

Hydrogen is currently produced from oil, natural gas, and coal. The production rate is estimated at approximately 50% from oil, 30% from natural gas, 15% from coal, and 5% from other sources. Hydrogen can be produced from the electrolysis of water, as water is electrolyzed into the element's oxygen and hydrogen, and in this way a gas of very high purity is produced. Water available in seas and oceans is the main source of hydrogen gas production. Solar energy can be used to produce hydrogen

by converting solar radiation into electrical energy using solar cells and then using the resulting electricity to decompose water.



Source: Data collected by researcher.

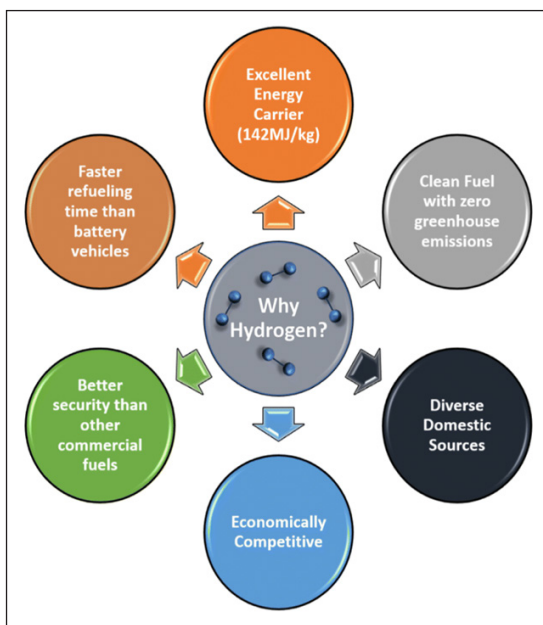
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Presence of Hydrogen

Hydrogen gas has all the ingredients that make it a successful fuel, as it is the lightest and cleanest, in addition to the possibility of converting it into other forms of energy with complete efficiency. Hydrogen is a gas that has no taste or smell and is non-toxic. It

consists of the diatomic molecule H₂, which is one of the most abundant elements in the universe. Of the planets and stars, they consist only of it or contain a high percentage of it. For example, it constitutes 75% of the components of the sun, and its energy is produced as a result of the fusion of hydrogen nuclei to form the element helium. Hydrogen has the smallest and lightest atom and is flammable and liquefied by pressure and cooling. It is included in the composition of many chemicals, which the most important of these are water and the organic compounds that make up living bodies, including plants and animals.

Hydrogen Oil



Source: Data collected by researcher.

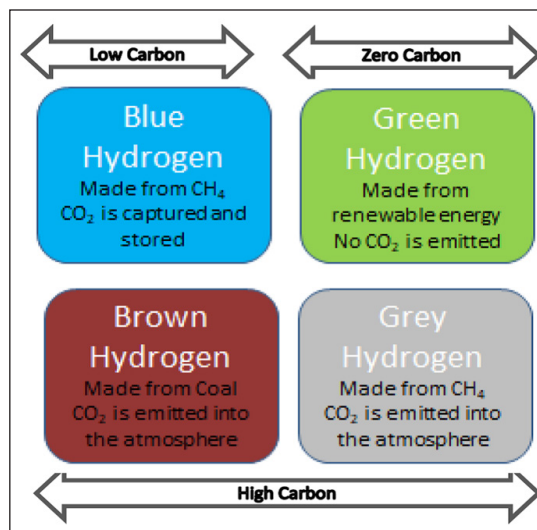
Despite its large presence in planets and stars, on the surface of the Earth it does not exist as an independent element. It is found in natural gas in small proportions and is found in great abundance combined with oxygen in the form of water in the seas, oceans and rivers. Therefore, the latter is the main source of fuel for the future. It is also present in Combined with carbon in the form of organic compounds necessary in food production,

From this we say that hydrogen plays an important role in the production of food, water and energy, which are among the basics of life today and in the future.

The idea of using hydrogen as an alternative source of energy began at the beginning of the twentieth century, but this process encountered difficulties, including: the high cost of its production. Separating hydrogen from oxygen by electrolysis or thermal analysis of water requires energy, and it also requires primary energy such as water to be produced, which hindered the development of Its production, which has witnessed increasing interest in recent decades due to its importance and qualifications that allow it to replace traditional energies.

This interest has been translated into developing methods for producing hydrogen and reducing, even if relatively, the cost of production. Scientists at the Center for Renewable Energy in the United States of America have also succeeded in producing it using solar energy. They have invented a device that separates

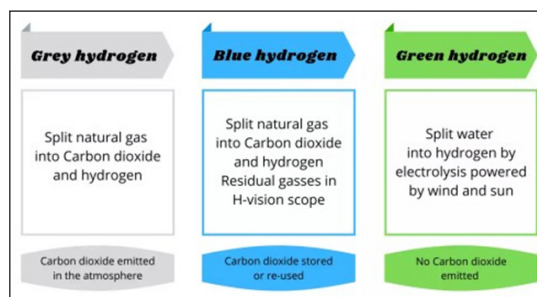
hydrogen from water and converts it into electrical energy at the same time using more than 12.5% of the solar radiation, and as previously mentioned, the most important obstacle facing them remains the cost obstacle, as the device is still not economical in cost.



Source: Data collected by researcher.

Hydrogen has many advantages that qualify it to be the fuel of the future, some of which were previously mentioned, and we add to it the ability to store, which is superior to other renewable energies that suffer from the lack of permanent availability of the same capacity, such as solar energy and wind energy... However, it is not considered a primary source of energy. Rather, it is an intermediate source for its production. What are the most important methods used to produce it?

Green Hydrogen Advantages and Disadvantages



Source: data collected by researcher.

Types of Hydrogen and Methods of Producing it

Hydrogen is produced from a raw material that contains it in its chemical composition, such as water, biomass, fossil fuels, or bio- and plastic waste, but is extracted into its final form using another source of energy.

Second: Methods of Producing Hydrogen

There are several methods through which hydrogen can be produced, the most important of which are: electrolysis of water, thermal analysis, in addition to its production through the influence of direct solar radiation.

Water Electrolysis

This method is considered the simplest and most widespread method known to obtain hydrogen from water. This method

depends on passing an electric current through the water to decompose it into its main components, hydrogen and oxygen. To do this, we need a device called an electrolysis cell and energy. The efficiency of this method reaches 80%, but it is It decreases to about 30%, if we take into account the efficiency of converting primary energy into electricity and then into hydrogen.

The most important obstacle to this method is the cost barrier, as it costs more to produce hydrogen by electrolysis of water than to produce it from fossil fuels.

Thermal Analysis of Water

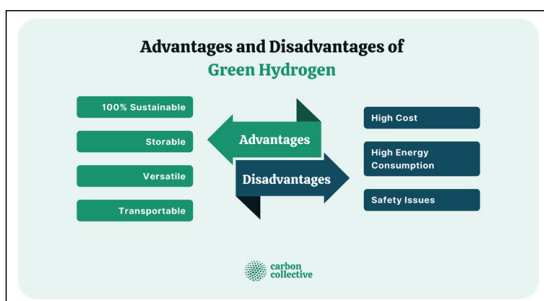
In order to decompose water into its elements by direct heating, it is necessary to heat it to about 3000 degrees Celsius or more, but reaching this temperature is not easy, and it is also difficult to find containers or materials that can withstand this high temperature, so scientists try to avoid these difficulties by performing electrolysis in several ways. Stages, provided that one or more chemical catalysts are used, such as iron oxide, sulfur dioxide, or calcium bromide and mercury, in order to carry out the reaction at lower temperatures, so that the highest temperature we need in the presence of the catalyst is 730 degrees Celsius.

Preparing Hydrogen by Direct Solar Radiation

Green plants derive the energy needed for photosynthesis from solar rays, while the hydrogen needed for the recovery process is obtained by plants from the decomposition of water into its element's oxygen and hydrogen, and this process only takes place in the presence of an intermediary, which is chlorophyll.

In the presence of sunlight and chlorophyll, scientists have tried to decompose water, and they have been able to find chemical compounds to replace this natural mediator. They have found that some dissolved salts in water can perform this role, so that when dissolved in water, the salts ionize into positive and negative ions, and under the influence of Solar radiation takes these ions or gives one or more electrons to and from the water molecule, leading to the decomposition of water into oxygen and hydrogen.

Green Hydrogen



Source: data collected by researcher.

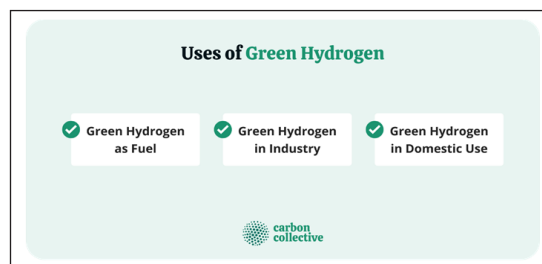
As a result of using one of these methods, the water decomposes, then the hydrogen is transported, stored, and distributed to consumers, as it can be used in most applications in which fossil fuels are used. The latter can produce hydrogen, such as coal gasification. However, we did not discuss this method because it is linked to a depleted source that pollutes the environment, and we are searching for Alternative sources of depleted energy.

Hydrogen Uses

Using hydrogen, we can operate planes, cars, trains, ships, factories, and heat homes, offices, hospitals, schools, etc. Hydrogen, in its gaseous state, can transmit energy like electricity over long distances and through transmission pipelines with high efficiency and at the lowest possible cost. Hydrogen can rely on energy fuel technology or other energy-generating machines. To provide the consumer public with electricity, pure drinking water, and hydrogen, as a chemical element, which has various uses and applications other than electrical energy. We can classify the uses of hydrogen fuel mainly into the following four main fields:

1. Fuel for transportation vehicles (cars, airplanes) that use hydrogen fuel cell technology and its broader applications for future use in power generation plants.
2. Using it as a battery with capacities that range from the small ones used in portable personal computers, all the way to hydrogen transport ships that transport it from renewable energy stations to remote electricity generation locations to solve the problems and costs of long networks and the energy losses across them.
3. Fuel that generates thermal energy through direct combustion in boilers in power stations, in addition to its use as propellant fuel in missiles.
4. It is a working fuel in nuclear reactors, especially the ITER reactor technology, which works on the principle of generating energy on the surface of the sun.

Uses of Hydrogen

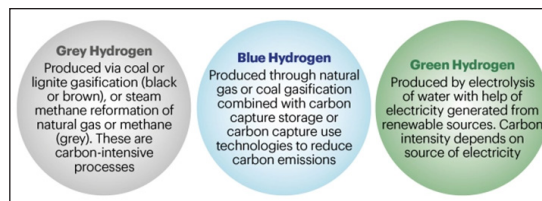


Source: data collected by researcher.

Hydrogen Technology

One of the most famous uses of hydrogen technology is fuel cells. Fuel cells use free hydrogen or hydrogen found in other types of fuel, such as methanol, ethanol, natural gas, and diesel oil. The extracted hydrogen is used to produce electricity. Hydrogen for fuel cells can also be obtained through biomass, wind, solar and renewable energy sources.

Hydrogen Types



Source: Data collected by researcher.

Third: Disadvantages of Hydrogen

Obtaining hydrogen is not easy and is also expensive. The main source of hydrogen is natural gas (i.e., fossil fuels). Natural gas

will cause emissions when used to produce hydrogen, and the gas is expensive and it is not economical to convert it to hydrogen at this stage. It may be better to use coal for this purpose, but it will require many years of development and investment [1].

Despite the many advantages that hydrogen has, it is not without disadvantages, including:

- The heavy reliance on natural gas to produce hydrogen, and this does not solve the problem of depletion of fossil energies as well as the emission of waste gases.
- The low energy per unit volume of hydrogen means the need for large tanks to hold it until needed.
- Hydrogen energy infrastructure differs from that of current energy sources, which means the need to make changes that may be costly.
- High costs of producing hydrogen. In order to produce a cubic meter of it in most of the devices currently deployed, we need from 4.5 to 4.8 kilowatts per hour. In order to reduce costs, research is focusing on improving the efficiency of these cells.

Hydrogen Energy in the Arab Republic of Egypt

It is possible to extract hydrogen energy from renewable energies such as hydropower, solar energy, and wind energy in Egypt due to the availability of infrastructure for previous energies, as there are many hydro stations, wind energy stations, and solar energy through which hydrogen can be generated [2]. Hydrogen can also be generated through traditional energies such as natural gas, as it is available in large quantities in Egypt [3].

Hydrogen can be generated from solar energy in Egypt, at the ideal location on the world map for generating hydrogen with solar energy, Lake Nasser in southern Egypt, due to its distinguished location and being the first candidate in the world to generate hydrogen with solar energy to exploit it as fuel at the local level and export the surplus to the outside world [4].

Hydropower is of great importance in Egypt, and hydrogen energy can be generated from hydropower stations to separate hydrogen in addition to generating electrical energy [5]. Therefore, Egypt has a promising economic potential to produce hydrogen from renewable energies.

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