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MODERN METHODS OF OBTAINING HYDROGEN

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Innovations in the field of physics undoubtedly lead to the emergence of new innovative projects in technology, production and industry. Therefore, it is important to solve existing problems with the help of physical knowledge. One of the biggest challenges facing the world community today is achieving optimal energy resources. Current problems such as dwindling oil and gas reserves, atmospheric degradation and global warming require a quality energy source, both technically and ecologically. Many scientists believe that hydrogen energy has such properties. Several countries of the world have developed their strategic projects for the use of hydrogen energy and have implemented certain parts of these plans. A number of state-level works related to hydrogen energy are planned in our country. It is a well-known fact that hydrogen energy is produced by hydrogen extraction. There are several ways to get hydrogen:
- Water electrolysis method;
- Using methane pyrolysis;
- In industrial methods;
- Through thermochemical reactions;

In several other ways. Electrolysis of water is a simple way to obtain hydrogen. An electric current is passed through the water and oxygen gas is produced at the anode and hydrogen gas at the cathode (Figure 1.1). Usually in hydrogen production for storage, the cathode is made of platinum or some other inert metal. However, if a specific gas is to be burned in situ to produce hydrogen, oxygen is required for combustion, and therefore both electrodes are made of inert metals. For example, iron is oxidized, thereby reducing the amount of oxygen released. Theoretically, the maximum efficiency (relative to the energy value of electricity produced and hydrogen produced) is in the range of 88-94%. The electrolytic method of obtaining hydrogen from water is based on the following reaction equation:

$$2H_2O \rightarrow 2H_2 + 2O \qquad (1.1)$$

Methods of obtaining hydrogen fuel are shown in the electrolysis method of obtaining hydrogen from water as a basic experiment. This process was tested in the Parkent district of Tashkent city. These experiments are shown in Figure 1.1. The reaction processes were studied. In the electrolysis method, the plates release oxygen and oxygen at the anode and cathode.[1]

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Figure 1.1. Extraction of hydrogen from water by electrolysis.

Hydrogen production from natural gas using methane pyrolysis is a one-step process that does not produce harmful gases known as greenhouse gases. Using this method, increasing the volume of hydrogen production, using hydrogen in industrial processes, ensuring a faster reduction of carbon emissions into the air, improving the quality of fuel transfer processes, and producing electricity from gas will have a wide effect. A simple example of methane pyrolysis is the production of methane (CH_4) bubbled at 1340 K (〖1070〗 ^0 C) over a metal catalyst containing molten nickel. Methane in the pyrolysis method leads to the decomposition of methane into hydrogen gas and solid carbon without other by-products based on the following formula (Fig. 1.2):

$$CH_4 \rightarrow C + 2H_2 \quad (1.2)$$

Solid carbon used in industry and produced from the above reaction can be sold as production raw materials or placed in permanent special containers, it is not released into the atmosphere and does not pollute water [2]. Methane pyrolysis is being

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produced and is considered suitable for commercial mass hydrogen production. The German chemical company "BASF Group" is experimenting with the production of methane pyrolysis on a global scale. Similar research is underway at several labs, including the Karlsruhe Liquid Metals Laboratory (KALLA) and the Chemical Engineering Laboratory at the University of California, Santa Barbara, which could further improve hydrogen production.

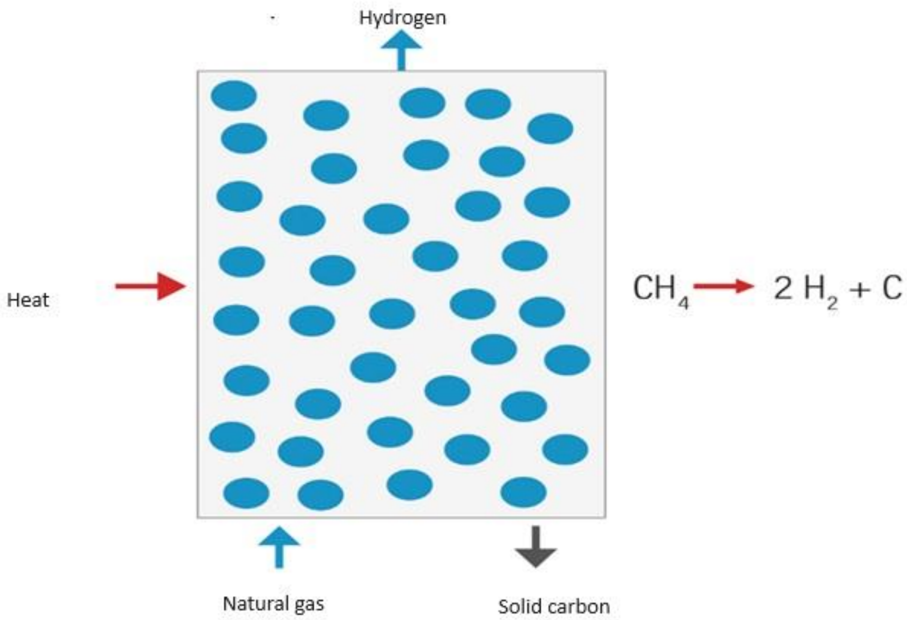

Figure 1.2. Schematic representation of hydrogen production using methane prolysis.

Hydrogen is mostly produced by the reaction of water with methane and carbon monoxide, where hydrogen is extracted from hydrocarbons at very high temperatures, and 48% of the hydrogen is recovered by steam processing[3]. The water vapor reacts with the carbon monoxide produced by steam processing, oxidizing it to carbon dioxide and turning the water into hydrogen. Commercial-scale hydrogen is typically produced by steam processing natural gas to reduce atmospheric greenhouse gas emissions or capture and store carbon, mitigating climate change. Steam processing is also known as chemical reactions known as Head Process and is widely used in the production of hydrogen for industry. At high temperatures (1000–1400 K, 700–1100 °C or 1300–2000 °F), steam (water vapor) reacts with methane to form carbon monoxide and hydrogen:

$$CH_4 + H_2O \rightarrow CO + 3H_2 \quad (1.3)$$

This reaction works at low pressures, but is nevertheless carried out at high pressures (2.0 MPa, 20 atm or 600 mm Hg). This is because high-pressure H_2 is the most expensive product, and variable pressure cleaning systems work better at higher pressures[2]. The product mixture is called "syngas" because it is often used to produce methanol and related compounds. Hydrocarbons other than methane can be used to produce synthesis gas with varying product ratios. One byproduct of this highly optimized technology is the formation of coke or carbon[4]:

$$CH_4 + H_2O \rightarrow C + 2H_2 \quad (1.4)$$

Thus, vapor formation usually requires excess H_2O. Additional hydrogen can be recovered from steam to carbon monoxide by a water gas exchange reaction, especially with an iron oxide catalyst. The following reaction is also a common source of carbon dioxide:

$$CO + H_2O \rightarrow CO_2 + H_2 \quad (1.5)$$

CO va H_2 Another major method for production involves the partial oxidation of hydrocarbons:

$$2CH_4 + O_2 \rightarrow 2CO + 4H_2 \quad (1.6)$$

There is also a coal reaction that can be a precursor to the shift reaction above:

$$C + H_2O \rightarrow CO + H_2 \quad (1.7)$$

Hydrogen is sometimes produced and consumed in the same industrial process without separation. Hydrogen is produced from natural gas in the so-called Haber process for ammonia production. Electrolysis of brine to produce chlorine also produces hydrogen as a co-product[5].

Many metals react with water to form hydrogen gas. However, the rate of hydrogen formation depends on several other factors. Acids often play a key role in obtaining hydrogen. Alkali and alkaline earth metals, aluminum, zinc, manganese and iron readily react with aqueous acids. This reaction is based on the Kipp apparatus, once used as a laboratory gas source:

$$Zn + 2H^+ \rightarrow Zn^{2+} + H_2 \quad (1.8)$$

Hydrogen production from acid-free reactions is somewhat slower. Since iron is a common construction material, its corrosion causes the formation of hydrogen:

$$Fe + 2H_2O \rightarrow Fe(OH)_2 + H_2 \quad (1.9)$$

Many metals, such as aluminum, react with water because they form passivated coatings of oxides. But the alloy of aluminum and gallium reacts with water. Under certain conditions, it can form hydrogen using aluminum:

$$2Al+6H_2O+2\,OH^- \rightarrow 2Al(OH)^{-4}+3H_2 \quad (1.10)$$

Some metal-containing compounds react with acids to form hydrogen. Under corrosive conditions, iron hydroxide (Fe(OH)2) can be oxidized by water protons to form magnetite and hydrogen. This process is described by the Schikorr reaction:

$$3Fe(OH)_2 \rightarrow Fe_3O_4 + 2H_2O + H_2 \quad (1.11)$$

This process occurs in the corrosion of iron and steel in oxygen-free groundwater and in the reduction of soils below the water table[20].

More than 200 thermochemical cycles can be used to separate water. Many cycles, such as the iron oxide cycle, the cerium(IV) oxide or cerium(III) oxide cycle, the zinc-oxide cycle, the sulfur-iodine cycle, the copper-chlorine cycle, and the hybrid

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sulfur cycle, convert water and heat from water and heat to hydrogen and oxygen through thermochemical processes without the use of electricity. is produced. In a number of laboratories (including France, Germany, Greece, Japan and the USA) is developing thermochemical methods of obtaining hydrogen from solar energy and water.

We have seen above that the methods of hydrogen production are chemical, electrolysis and electrochemical. Each method destroys the use of natural resources, so all three methods are economically and environmentally useless, because natural resources are exhausted. The problem of hydrogen energetics is twofold: for the production of this substance there is a high risk of waste and explosion to other energy sources (oil, electricity, gas). In addition, as we noted above, there is no clearly defined and economically useful mechanism for obtaining hydrogen energy, although experts are actively developing options for the production of hydrogen fuel. But there are difficulties in obtaining it. More attention is being paid to obtaining hydrogen from water in an effort to find ways to eliminate the shortcomings. In this regard, the potential of water as a source of hydrogen energy is taken into account.

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