

AUTONOMOUS WIND-HYDROGEN STATIONS

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Introduction

Within the last decades the world community, jointly with other problems, was trying to solve very urgent problem connected with catastrophic depletion of natural non-renewable resources and environment protection due to overuse of these resources. Under available estimations oil and gas will be completely depleted within the next 40-50 years, coal – within 150-200 years. In this connection the leading countries of the world activate scientific-research and project-design works. The conclusion of these works is that in the new millennium the main fuel for power system will be hydrogen.

The reason of such increased attention to the problem of fuel cells creation is their advantages.

As a consequence, scientific-research and project-design works are being activated on problems of hydrogen utilization as ecologically clean fuel and power storage device in energetic, city transport, rocket-space engineering, submarines and other traditional areas of hydrogen utilization.

Taking into account prospects of the power industry development in the world the core of the problem is a search for and elaboration of scientific-technical solutions, on the basis of which it is advisable to create autonomous stations for efficient and safe production, storage and transportation of hydrogen as a fuel.

Results and discussion

Hydrogen is produced in the world by two main methods:

1. Chemical conversion of hydrocarbons (90 %)
2. Electrolyte decomposition (10 %)

The chemical conversion means consumption of traditional hydrocarbon raw material (natural gas) and power-carriers (gas, oil, coal), but all of them are going to a complete depletion.

As to the electrolytic decomposition, the raw materials is water, amount of which is unlimited, and electric power generated under use of non-renewable power carriers. Since utilization of non-renewable power carriers cannot be considered as prospective, at the time being a possibility is studied to use renewable power sources, such as wind, sun, tides, waves etc. The most attractive from them is wind.

So, a tempting idea is rising – to join in one and the same complex a wind power plant and electrolyzer. This idea is being implemented by many scientists and engineers in Europe and USA. At one time production of electrolytic hydrogen was developed considerably in Korea and Japan. Some large Italian enterprises used to produce ammonia also from electrolytic hydrogen. In the last years India and Egypt constructed large plants for water electrolysis in order to provide production of synthetic ammonia with hydrogen. In some other countries the electrochemical method of hydrogen generation is used for supplying middle and small consumers of different branches with hydrogen and oxygen. The modern compact electrolysis plants can produce hydrogen of up to 4 t per day at pressure of 7 kgf/cm² and current's density of about 1,6 A/cm²; their efficiency is 60 %. At present, in order to increase efficiency of electrolyzers, the operating pressure is being increased up to 200 kgf/cm², novel electrolytes are used and electrodes with coatings from noble metals. In future the efficiency of electrolyzer will be increased to 70 – 80 %, as expected. Besides, utilization of the heat now radiated by electrolyzers into surrounding, will allow to cut consumption of electric power for production of 1 sm³ hydrogen to 3.5 kW·h. Since the work of the power station as a whole depends on wind speed stability, selection of basic

parameters of the complex (electrolyzers performance, parameters of hydrogen storage) is determined with allowance for specific region and dislocation of the WPP.

The main difference of cyclic reversible generator of high-pressure hydrogen from other known electrolyzers is two-staged operation. The first stage is separation of hydrogen, amount of which in this cycle is determined by capacity of an active element (oxygen is accumulated in a form of a chemical compound). At polarity change a discharge of active elements starts. The accumulated oxygen is extracted as gas and transferred into the storage system or to a consumer. Then the cycle is repeated.

Investigations have shown that it is advisable to create wind-hydrogen stations for ensuring life-support of autonomous regions; it was also stated that utilization of hydrogen as a power accumulator is technologically achievable and characterized by high power capacity.

Resume

The Yuzhnoye State Design Office (SDO) jointly with other organizations-participants has submitted a Project Agreement #3591 "Autonomous Wind-Hydrogen Station" to the contest established by the Science and Technology Center in Ukraine (STCU).

The subject of the Project is creation of scientific-technical solutions and their experimental verification in the interest of creation of industrial stations converting the primary wind energy into commercial hydrogen and oxygen on the basis of electrolytic splitting of desalinated water.

Construction and operation of these stations in regions characterized by moderate and high wind potential will allow partial solution of the world energy/ecology problems that are becoming more and more acute as the non-renewable energy sources are being exhausted. The expected results of the Project:

1. Scientific-technical basis will be established for the large-scale construction of sufficiently non-expensive autonomous wind-hydrogen stations, including elaboration of:

- a simplified wind-power plant of 250 kW power with a rotor self-protected against excessive rotational speed, adapted for operation with an electrolyzer only;

- a module of electrolyzer characterized by high pressure ($\sim 200 \text{ kgf/cm}^2$), high hydrogen output ($\sim 7 \text{ m}^3/\text{h}$) and better specific characteristics against the current industrial electrolyzers;

- electrodes of updated configuration with optimized active mass for electrolyzers of high pressure;

- technology and design for a system of compact storage of hydrogen in bound state.

2. The established scientific-technical basis will allow construction of autonomous wind-hydrogen stations, economical efficiency of which is by 10-15 times higher than that of the grid-connected wind-power plants. This advantage is derived from the higher cost of hydrogen against the cost of eclectic power consumed for production of the hydrogen.

3. One such wind-hydrogen station at continuous operation in the specified mode can produce hydrogen in amount of $\sim 100 \text{ kg}$ per 24 hours. This corresponds to about 250 l of petrol in power equivalent, under simultaneous decrease of CO_2 emission into atmosphere in amount of 500 kg.

The broad introduction of power installations with FC using electrolytic hydrogen produced by the autonomous wind-hydrogen stations will allow partial solution of the world energy/ecology problems.

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