UDC 539.43:620.178.3(045)

O.Y. Surovtsev, M.F. Molodtcov, PhD, O.I. Yurchenko
(National Aviation University, Ukraine)

Modern view: hydrogen - as a source of energy for aircraft, as an integral part of the maintenance of airworthiness

The article discusses the process of transition to the use of hydrogen in aviation as a gas to a source of energy for hydrogen engines for transport, in particular for aircraft.

Evaluating the current state of operation of aircraft, to study the problems faced by air transport, we observe a constant increase in demand for various types of aviation works (air transportation: both passengers and cargoes, etc.). This indicates that the issue of economic efficiency of performing these works with providing the necessary level of safety of flights and the functioning of the elements of technical systems (air engines, power plants, etc.), as well as maintaining the flight suitability of aircraft, remain relevant and needing regular monitoring, analysis and search for new approaches. To existing technologies or creating new materials [1].

Investigating new introductions in the aviation industry, you understand that the new one is forgotten old: once the hydrogen has already attracted attention to both inventors and aircraft - even at the beginning of the 19th century, and as a source of energy, and as gas, lighter than air, for filling the airship. After the catastrophe with the airship "Hindenburg" began to use helium.

The first hydrogen engine was described in 1806 by the French inventor of Francois Isaac de Rivaz, which received hydrogen with electrolysis of water. But the first patent for the hydrogen engine was issued in the UK in 1841, and in 1852, in Germany, an internal combustion engine (DVS) was built in Germany, which worked on an air-hydrogen mixture. They tried to use hydrogen traditionally - burning in pure form, or in a mixture with kerosene, for aircraft engines.

In 1933, the Norwegian oil and gas and metallurgical company Norsk Hydro Power was converted one of its small trucks to work on hydrogen. The chemical element was highlighted due to the decomposition of ammonia and flowed into the engine [2].

In the USSR, aircraft designers turned to hydrogen in the 1970s (in the study of the possibility of using liquid hydrogen and liquefied natural gas (LNG) as an alternative fuel for aircraft engines (Samara engine engineering KB, currently - PJSC "Kuznetsov", Russia). First NK-88 became such an experimental hydrogen engine, created on the basis of the serial engine for Tu-154 NK-8-2 and the first flight Tu-155 took place on April 15, 1988, the right engine in its power plant was NK-88 working on liquid Hydrogen. Also, hydrogen was considered as gaseous fuel and in rocket-building - RD-0120 hydrogen engines used the Soviet orbital aircraft (LA) "Buran" [3].

The hydrogen engine is a variety of engine, which is used to produce hydrogen energy as a fuel. The engine consists of two main parts - this is a fuel cell as a primary energy generator and an electric motor that uses it to change its type.

The fuel element that works on the water - essentially a hydrogen engine. Fuel element (otherwise - electrochemical generator) is a device for converting chemical energy to electric. The same happens in conventional electrical accumulators, but in fuel cells there are two important differences: First, they work until fuel comes; Secondly, the fuel cell does not need to recharge.

The fuel element consists of many dozen cells, each in about centimeter thick. Each cell consists of two electrodes separated by electrolyte. On one electrode (anode), fuel (hydrogen) is supplied, to another (cathode) - an oxide (oxygen of air). Hydrogen does not burn here, the chemical reaction of oxidation occurs at low temperature in the presence of a catalyst. The purpose of the device, using this reaction, divide the positive and negative charges in space and create a voltage between them. Therefore, an electrolyte that fills the space between the electrodes must have the ability to pass through the protons (i.e. hydrogen, and do not skip electrons. On an anode, hydrogen decomposes on electrons and protons, and then protons pass through the layer of electrolyte, reach the cathode and, connecting with oxygen, form water [2].

By today, the use of hydrogen in transport has already passed the stage of pilot projects. Fuel cell cars are mass-produced by major car manufacturers: Honda, Hyundai, Audi, BMW, Ford and others.

Such cars have fuel cells, compressed hydrogen cylinders, as well as a rechargeable battery for a cold start and maintaining peak loads and accelerations. The output power of serially produced models from 70 to 130 kW, the maximum speed is 160 km / h. Moreover, the speed is limited not by the engine as such, but a system control system limiting hydrogen flow within one kg per 100 km run [4].

Theoretically, Puffal Elenty, Phalnaya Elenty, Putzyuc at Sumyshi, Radier, can pass 85%. Increased 75% of the KKD Blisko Dviguni vzhzh, Nizh Otvichi, Bilsh Nizh Otvichi, Vidpovidnye Showing Dviguniv's internal urg.

On the fuel cells are produced scooters and even bicycles. The 15 countries already have more or less developed networks of hydrogen fuel, in the number - Germany, Denmark and Italy are sufficient for the ubiquitous use of cars on fuel cells.

"Found" fuel elements and railway transport. In Germany, the world's first train in the hydrogen fuel cells - Coradia Ilint was commissioned. On the roof - the tank with hydrogen and the fuel cell. Train speed - 140 km/h, the distance of the trip at one refueling is 1000 km, and the refueling lasts 15 minutes. In the Netherlands, maritime courts are produced on fuel cells [3].

Regarding aviation, the use of fuel cells is very relevant in the development of electroavitations. To date, in most countries, the fuel elements "penetrated" so far only on unmanned aerial vehicles. The British company Cella has developed solid hydrogen granules and in March 2016 launched a drone in Scotland. The achievement is that the entire system is more easier than lithium batteries of the same output characteristics.

In Germany, China and the United States have already appeared and manned apparatus on fuel cells. Hydrogen-operating four-engine HY4 has made its first 15-minute flight around Stuttgart Airport. In Russia in 2014, a producer of hydrogen fuel cells appeared - at Energy. The company specializes in rechargeable systems for drones, including military. It was its fuel cells that were used for drones who were filmed by the 2014 Olympics in Sochi.

Modern hydrogen production technologies are far from perfection. Despite this, the giants of the chemical industry are already receiving 500 billion m³ of hydrogen per year. Half of the amount produced on ammonium fertilizers, the rest - for the production of steel, glass, margarine, etc. Basically, hydrogen is obtained by means of steam refinement of natural gas: methane at high temperatures (900 °C) in the presence of a nickel catalyst reacts with a steam. So far, such a hydrogen is the cheapest, but the problem lies in the need for an analogue of a fuel tank, because hydrogen in the fuel tank does not null. This is today the largest technical difficulties. In general, the fuel element on aqueous is fully ready for use. Lack of trifles: make it compact and cheaper [4].

The most promising scientists consider the preservation of hydrogen in high pressure cylinders - more than 350 atm. (an aspect number of up to 18% at a pressure above 500 atm.) or receiving it directly on a board of other fuel (methanol or liquid hydrocarbons: gasoline, diesel fuel, etc.), in special catalytic reactors (an aspect number of about 10%). Such systems developed by Russian scientists and for intelligent dimensions provide hydrogen stock for a few hundred kilometers. Designers are also faced with other problems. Yes, the car (primarily the cabin) must have a system of hydrogen safety [5].

Today, the following advantages and disadvantages of hydrogen engines are defined. In particular, the combustible shape of hydrogen at room temperature and normal pressure is represented as a gas, and this causes some difficulties in the storage and transportation of such fuel. There is a serious problem when designing safe tanks for hydrogen, as fuel, which means the cylinders with this substance require periodic verification and certification, which can be performed only by qualified specialists who have a relevant license. Also remaining expensive in maintaining the hydrogen engine, not to mention the very limited number of filling stations. Do not forget that the hydrogen installation increases the weight of the vehicle, which means that the decrease in maneuverability and commercial burden. The benefits are also there, firstly, the level of pollution of the environment toxic exhaust gases is reduced, secondly, the mass production of hydrogen will be able to reduce the prices of traditional fuel and reduce interruptions in the supply of conventional types of fuel fluids. Many countries have already built pipelines for methane, which are quite easy to adapt to hydrogen pumping, followed by delivery to refueling. You can produce hydrogen in both small scales and massively on large, centralized enterprises. The growth of hydrogen production can serve as an additional incentive for the growth of deliveries of this substance for domestic purposes (for example, for heating, etc.).

The famous European firm Airbus designs at once three options for a passenger aircraft with a hydrogen engine and hopes to make the first commercial flight in 2035. Engines for all three aircraft are the gas turbine engines converted under hydrogen fuel. At the same time, these aircraft will also have hydrogen fuel cells producing electricity. It is assumed that such a combination will create an ecologically impeccable and efficient type of air transport [5].

Airbus hopes to have the first in the world to make a commercial aircraft on hydrogen fuel. According to the company's calculations, the use of hydrogen can reduce greenhouse emissions from aviation traffic at least 50%.

Conclusions

Analyzing the historical stages of the use of hydrogen as a source of energy for vehicles, both cars and aircraft, clearly seen the prospects for the use of hydrogen on the basis of an electrochemical reaction. However, it should be borne in mind that in a waterway, as in aviation fuel, other characteristics, rather than that of the aviation kerosene, therefore, it is necessary to develop the storage of hydrogen fuel, as well as the modern architecture of the aircraft themselves.

References

1. https://www.aviapanorama.ru/2019/12/vozdushnomu-sudnu-na-vodorodnoj-tjage-byt/.
2. https://trends.rbc.ru/trends/industry/6048e0629a794750974c67a7.
3. https://uk.wikipedia.org/wiki/Водневий_двигун.
4. https://auto.today/bok/4339-kak-rabotaet-vodorodnyy-dvigatel.html.
5. https://www.kommersant.ru/doc/4501624