

Experience in mastering of hydrogen technologies on automobile transport

Ipatov A. A., D. Sc. (Economic), prof.;
Khripach N. A., Cand. Sc. (Tech.), associate professor;
Lezhnev L. Yu., Cand. Sc. (Tech.);
Federal R&D Center RF FSUE "NAMI", Moscow, Russia,
e-mail: khripachna@nami.ru

The principally new technological approach to the energy safety problem is already called the hydrogen or more precisely atomic-and-hydrogen power engineering. Call "peep work on perspective lines of the power engineering – hydrogen and fusionable" was made by the President of Russia in his Message to the Federal Assembly May 10, 2006, and "to intensify the scientific researches for working-out of transport facilities operating on the gasoline/hydrogen fuel and hydrogen fuel components for promotion in creation of "the hydrogen economy" on the "Summit-G8" held in Saint Petersburg in 2006.

Use of the automobile transport in the human being life became an integral part of the public development. But the motorization of the society puts forward a number of series social problems, among which are the ecology and preservation of natural resources. Automobiles are the main energy consumers and one of the main atmosphere pollutants. The most energy-intensive and ecologically dangerous components of the automobile is the power plant. The main lines of improvement of the automobile power plants at the present time are determined by two most important social-and-economic problems:

- rational use of the fuel of the oil origin, including its replacement by alternative energy carriers;
- reduction of the harmful effect of the automobile transport upon the environment.

The existing measures of reduction of toxicity of the used gases are insufficient for performance of perspective norms and, therefore, even today the search works for creation of principally new technologies are being performed, which shall bring the ecological danger of automobile transport during this century practically to the zero level. It is required to pay attention to the following perspective alternative lines:

1. Use of the alternative ecologically pure fuels of the oil origin and increase in their energy intensity.
2. Automobiles with hydrogen internal combustion engines of different types.
3. Accumulator vehicles with combined drive.
4. Accumulator vehicles with electrochemical generators fed with hydrogen or hydrogen synthetic gas produced aboard the transport facility due to the catalytic decomposition of the hydrocarbon fuels of non-oil origin, for example, methanol.

One of the best solution may be the use of the hydrogen or synthetic gas with high concentration of the hydrogen as the alternative fuel for the power plant of the automobile transport.

FSUE "NAMI" performs works in the field of mastering the hydrogen technologies on the transport for more than twenty years. During the last years, taking into account the actuality of the hydrogen theme in solution of the global power engineering safety of the country, these researches are changed over to a new qualitative level.

Organized in the FSUE "NAMI" is the scientific-and-research and experimental-and-design Center of the hydrogen power engineering and combined power plants. The specialists of the institute organized the specialized test complex for research of the

hydrogen, including combined, power plants of automobiles with the use of gaseous hydrogen and oxygen. At the present time it is modernized for operation with the liquid hydrogen and oxygen.

Performed are works on creation of different types of hydrogen and combined automobile power plants, which are financed both by the federal budget funds and business companies.

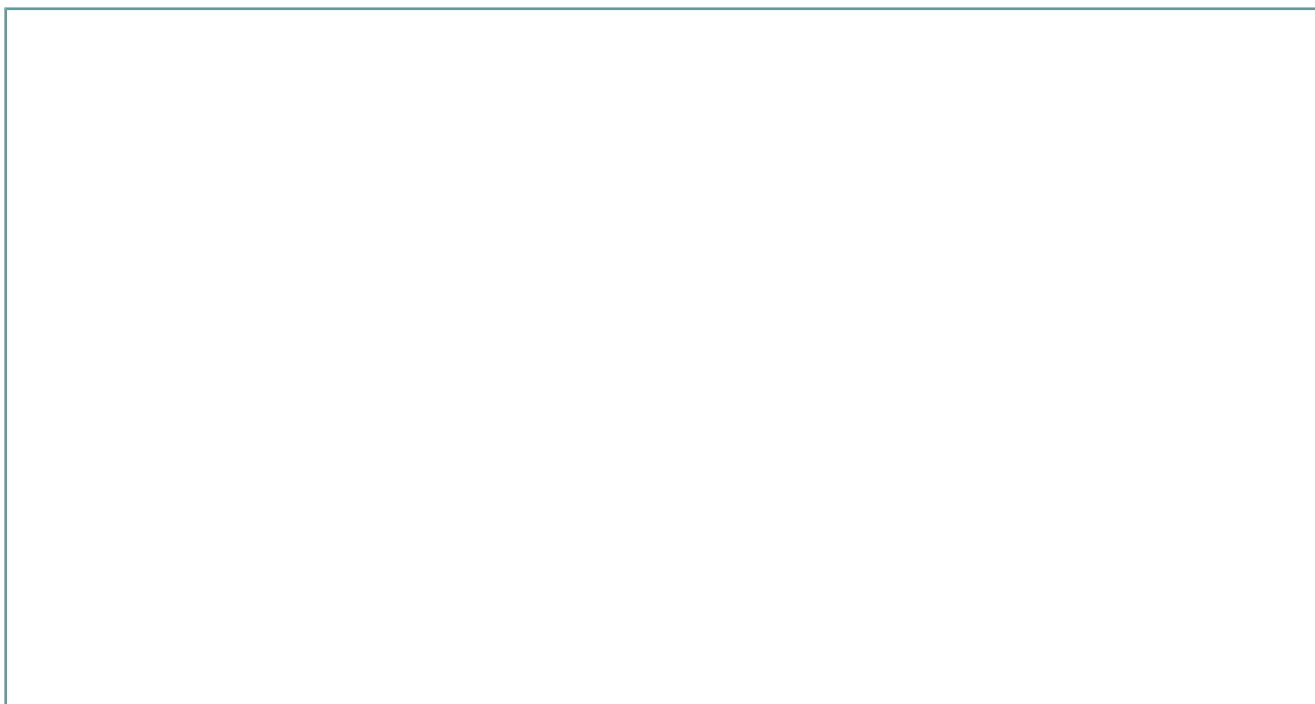
FSUE "NAMI" is widely presented in the public, state and international organizations, which make researches oriented to development of the hydrogen power engineering and combined power plants on the transport. Given below is the list of some of them:

- World forum for coordination of rules in the field of transport facilities (WP.29) within the framework of the ECE UN;
- International partnership for hydrogen technologies;
- Association of automobile engineers of Russia;
- National association of the hydrogen power engineering;
- International organization for standardization.

The specialists of the FSUE "NAMI" are constant members of the organizational committees of symposiums, conferences and seminars on automobile-building, transport and hydrogen subjects.

For the purpose of providing the institute with qualified personnel the scientists of FSUE "NAMI" are attracted for reading of special courses of lectures, conduct of practical and laboratory studies, scientific leadership of the course and diploma projects, as well as the master and candidate acts of the higher education establishments of the country, such as MSTU "MAMI", MADI (STU), etc. Due to such approach to the preparation of the personnel the leading specialists have the possibility during the training practice and diploma design to master the modern elements of creation of the hydrogen and combined power plants for the automobile transport and after employment in FSUE "NAMI" properly master their engineering and scientific career.

Proceeding from the FSUE "NAMI" experience, distinguished in the works on the hydrogen power engineering may be three stages: actual, middle- and long-time (Fig. 1).



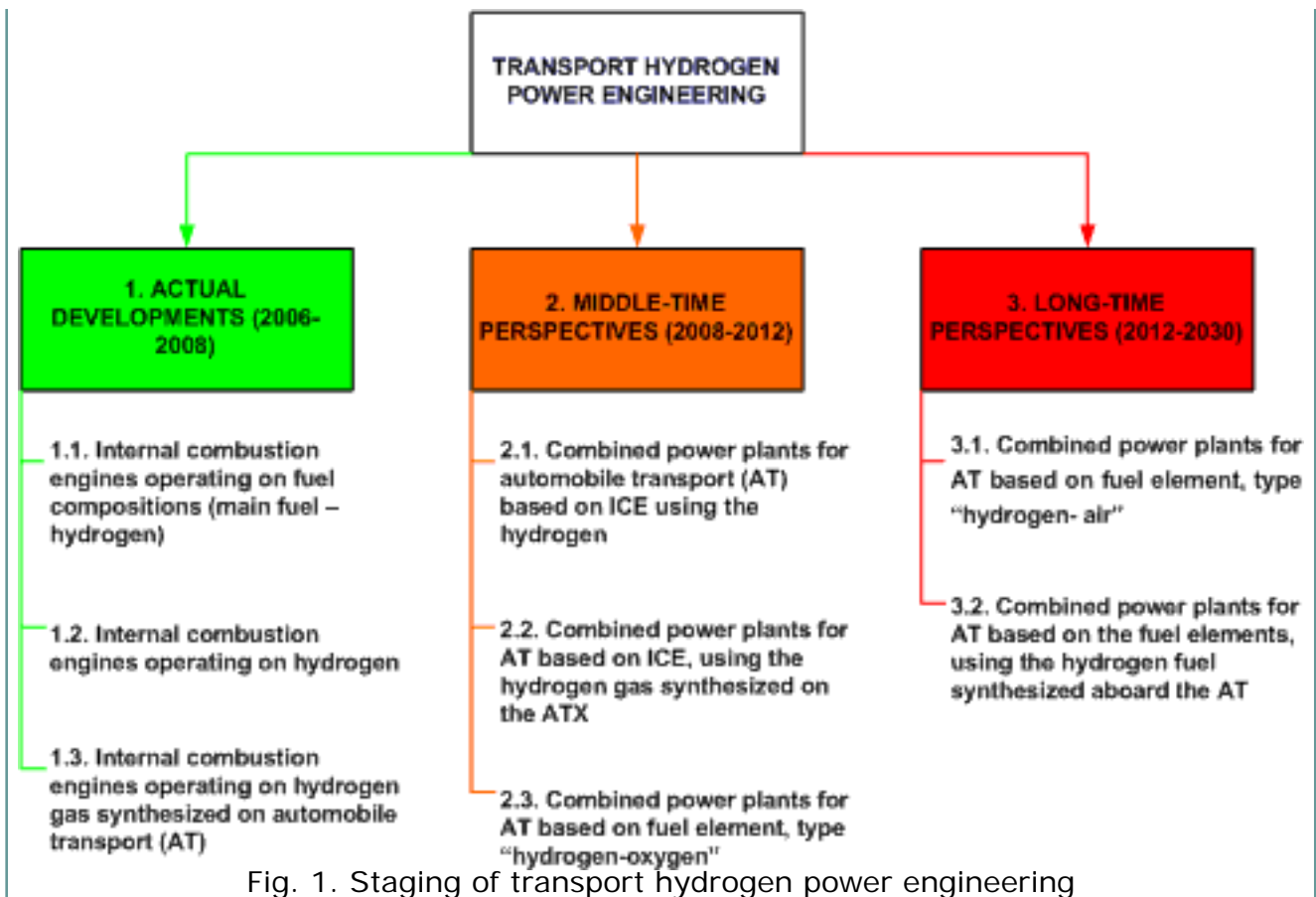


Fig. 1. Staging of transport hydrogen power engineering

Related to the actual developments shall be development of internal combustion engines completely or partially (with addition to the main fuel) operating on the hydrogen fuel synthesized aboard the automobile transport (AT) from alternative energy carriers (methanol or methane) or stored on it in compressed or liquid state. The advantage of these solutions is their quick realization in the series production, use of the existing transport infrastructure (in case of the hydrogen synthesis aboard the AT), considerable (up to 45%) reduction in exhaust of harmful substances and improvement of the economic efficiency (up to 15–20%) of the automobile. Related to disadvantages shall be absence of infrastructure of the automobile filling with liquid or gaseous hydrogen, which is common for all stages of development of the transport hydrogen power engineering.

The middle-time perspective developments shall be automobiles with combined power plants based on the internal combustion engine, operating on the hydrogen fuel synthesized aboard the automobile transport. In this case the engine will operate at conditions close to stationary ones, which will reduce in exhaust of toxic components with its used gases (up to 60% relatively to the traditional gasoline engine), improve the operating conditions of the hydrogen synthesis system and, thus, reduce the fuel flow rate (up to 40–45% relatively to the traditional gasoline engine). When working out such an automobile the electromechanical transmission and energy accumulating sources shall be created aboard the automobile (buffer memories – traction batteries, supercondensators).

Related to the further projects shall be the automobiles with power plants based on the fuel elements. Their long-time working-out is determined firstly by the absence of the compact fuel elements in the Russian Federation with characteristics applicable for the automobile transport. But, the automobile with the combined power plant based on the hydrogen internal combustion engine is the first step for development of the AT with fuel element. Its components – electromechanical transmission, buffer memories, hydrogen generating system – shall be all-purpose for automobiles with the combined power plant, i.e. when working out the fuel element of the native industry, it may become the substitute of the hydrogen internal combustion engine. The experience of foreign researches shows that such fuel element at the price of

200–250 US\$ per 1 kW may be produced in at least 20–25 years.

In all listed fields FSUE "NAMI" has a number of series results. One of the last developments of FSUE "NAMI" is the principally new transport facility (on the chassis of truck ZIL-5301) with the power plant based on the fuel cell operating on hydrogen (Fig. 2).



Fig. 2. Truck on chassis of truck ZIL-5301 with combined power plant based on hydrogen fuel cell