The effective technology of hydrogen production in the transition

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Most intense on the energy market is the sphere of motor fuel and provision of energy for industrial technological processes. For this reason a diversification strategy for this sector draws the increased attention in all large countries of the world. Previous Russian experience (work on the program of Nuclear-hydrogen Energy) and the present global tendencies of the innovative nuclear reactors (Generation-4, NPNG) give the basis to assert, that the decision of this problem lays on ways of creation of a new technological platform of use high-temperature gas cooled reactors (HTGR) not only for increase of generation efficiency of the electric power, but also for nonelectrical application of an atomic energy, including, for manufacture of hydrogen from water. The share of this new segment of the market of atomic engineering does not concede on scale to electropower application and can make, at least, 50−100 energy complexes on 2.5 GW (thermal) by 2050 with manufacture 25−50 Mt of hydrogen for Russia and external market.

Unique ability nuclear reactors of a HTGR type to produce high temperature up to 950−1000°C opens opportunities of hydrogen manufacture from water and electric power with high efficiency and by that to create a basis technologically of clean hydrogen energy and to supply a substitution of organic fuel in power-intensive industries.

The transition to the large-scale technology of hydrogen production from water will require significant expenses for completion of technologies to make by their competitive, and also development of the market of hydrogen fuel and infrastructure, ensuring this market.

In the nearest prospect for the basic production of hydrogen production and its derivative in industrial scales was and there is a conversion of natural gas.

In process of growth of expenses on production and delivery of gas with remote natural gas sources the increasing comparative efficiency begin to get technologies, lowering the charge of natural gas burnt as fuel, not only in power industry, but also in other branches, and also in the most natural gas consuming processes.

From this point of view in the long term will begin to be formed economic stimulus to creation combined technologies, in which the significant part of power processes will be shifted from hydrocarbon fuel on new more effective and safe for an environment energy source and, first of all, for large scale manufactures and large power — on high-temperature nuclear reactors of the next generation.

Development of high-temperature gas cooled reactors for various application has become the project of modular reactor GT-MGR, developed by joint efforts of the companies of Russia, USA, Japan.

On the basis of this project by the order of Concern "RosEnergoAtom" the conceptual design study of an opportunity of binding to reactor MGR of hydrogen production is executed. Such project with nuclear energy unit MGR-T was worked in a combination to new process of hydrogen manufacture by adiabatic steam reforming of methane (ASRM), in which charge of natural gas approximately is twice reduced and about half of hydrogen is made from water.

The basic features of technology ASRM coupling with MGR-T, provide oxygenless manufacture of hydrogen and its products at rather low capital expenses. On the

basis of a nuclear-hydrogen complex consisting from 4x modules MGR-T by capacity 600 MW (thermal) everyone process unit with an hydrogen capacity approximately 0.5 Mt/yr can be created with simultaneous manufacture about 5 TW.hr/yr of the electric power.

Now large scale hydrogen production and hydrogen-containing products is carried out in the world basically by steam conversion of natural gas — methane (SCM) and such technologies of hydrogen production in the near future will stay basic. At the same time rise in prices on hydrocarbons, the raw and ecological restrictions of process of steam conversion of methane stimulate development and application of industrial processes with use of water as initial raw material for manufacture of hydrogen, that will require heat supply at higher temperatures in comparison with mastered earlier.

If to try to make hydrogen in necessary volumes only at the expense of natural gas, by 2025 for manufacture 200 Mt of hydrogen it would be required to burn 1,200 billion scm of natural gas, that is about half of its today's world production, that would cause unacceptable loading in the intense balance of natural gas.

The solution, in our opinion, consists in application of new nuclear sources — high-temperature reactors for hydrogen economy, that at development of technologies ASRM will allow on 500 billion scm to reduce the charge of gas (is commensurable with productivity of concern "Gasprom"), and further, passing on decomposition of water, completely to refuse from hydrocarbons as hydrogen source.

The preliminary technical and economic estimations on manufacture of hydrogen in perspective processes with thermal and electrical energy from MGR-T show, that the method of steam conversion of methane is competitive with usual technologies at the today's world prices of natural gas and without the account potential making of the taxes to emissions CO_2. The development HTGR are conducted on moderate temperatures of used heat in processes (no more than 850°C). Increase of helium temperature up to 1000°C will allow to increase efficiency of processes of manufacture of hydrogen, however thus cost of reactor installation creation is increased.

In recalculation on nuclear capacities necessary for future volumes of hydrogen, in variant "HTGR-ASRM" it is necessary to develop nuclear-hydrogen complexes by general capacity 1,500 GW (th). (with simultaneous consumption natural or synthetic methane in volume 2.5−3 trillion scm), and in variant "HTGR- production of hydrogen from water " (by thermochemical decomposition or high-temperature electrolysis) the input of necessary capacities should make ~10,000 GW (th), that is commensurable with required growth of nuclear capacities for manufacture of the electric power under the strategy of its intensive development.

On seen, the intermediate strategy using technology HTGR-ASCM in the transition period will be realized when cost of natural gas will be commensurable with cost of nuclear heat made by HTGR, and then, at increase of natural or synthetic methane cost up to a level exceeding cost of nuclear heat in 3.5−4 times, i.e. approximately up to cost 500−600 US$/ 10^3 scm of NG, will begin to become to competitive hydrogen produced by decomposition of water.