HYBRID fusion-fission SYSTEMs – YESTERDAY, TODAY AND TOMORROW

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Combining nuclear fusion and fission reactions in a single design opens up the possibility of achieving fundamentally new characteristics and parameters of energy systems and special applications. Fusion–Fission Hybrid Systems (FFHS) have very quickly (less than 10 years) reached a leading position and effectively solve problems in the field of nuclear weapons. The peaceful use of FFHS in the energy sector, which was also sought by the creators of nuclear weapons, has proved to be much more difficult. For peaceful applications of nuclear reactions it was not enough even the past 65 years since the test of the first hydrogen bomb – "Sakharov puff".

The problems of reducing the power in hybrid systems to acceptable levels of energy units
GW (t) were much more difficult than to implement explosions of megaton level.

The report discusses the three stages of FFHS development: the initial one in the first 50 years till 2000, the current stage 2000–2020 and the long-term targets for 2020–2050.

The first stage is associated with the names of A. Sakharov, E. Teller, V. Orlov, V. Blinkin, who revealed the potential of FFHS in the energy sector and helped to identify areas of potential applications: production of neutrons for breeding of the fuel nuclides, the production of energy and burning/transmutation of minor actinides and long-lived isotopes of fission products in a subcritical active cores. Interest in these applications increased and faded as the parameters of thermonuclear systems increased, reaching a maximum in the construction of the largest TFTR and JET tokamaks, which demonstrated the achievement of DT synthesis power of more than 10 MW in the second interval of durations.

The modern stage can be associated with the names of R. Rebu, E. Velikhov, W. Stacy, Yu. Wu. After the decision was made in 2006 to build an ITER international tokamak with a DT synthesis power of about 500 MW, it became clear that part of the hybrid systems associated with the synthesis is approaching the parameters of energy systems. During the same period, the research society started to search for new applications of neutron sources for solving problems of materials science and fundamental physics (neutron scattering).). Activities in this direction were supported by the IAEA, due to the fact that the sources of MW-level meet the requirements of energy systems, and FFHS created on their basis can use materials designed for fast reactors. At present, the design of such FFHS is at the level of conceptual design, which allowed to determine the general parameters of the FFHS and to outline the program of necessary R& D for the engineering design and construction of facilities.

The future development of the FFHS is being actively discussed in the framework of the conference FUNFI – (synthesis for neutrons). It is associated with the optimization of processes in the generation of neutrons synthesis and transformation of nuclear nuclides. It can be noted that there is increasing interest in breeding tritium by FFHS for the launch of thermonuclear power plants, as well as in the transmutation of minor actinides and the production of synthetic nuclear fuel for fast and thermal reactors. Current forecasts indicate the feasibility of industrial FFHS by 2050.