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Physical and technical basics of the concept of a competitive gas cooled fast reactor facility with the core based on coated fuel microparticles

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At the turn of the century a new step in the development of gas cooled fast reactors (GCFR) in the world was made through international cooperation in the elaboration of innovative nuclear energy systems. In the mid of 2000s, in Russia rather active investigations in this direction were resumed under the scientific supervision of NRC "Kurchatov Institute", what happened largely due to the extensive development of technologies of high-temperature thermal reactors in this time.

The paper presents the results of the stage-by-stage development of a modern Russian proposal for the technical concept of a reactor facility with a high temperature fast helium cooled breeder reactor with expanded breeding working in a closed fuel cycle and having its own role in the nuclear energy system due to efficient electricity generation, and, in the longer term, possibility of industrial applications. It is expected that the unit will have the level of specific capital costs comparable to competitive nuclear energy sources.

The concept of a reactor facility with the BGR-1000 reactor of 1000 MWe capacity is based on the synthesis of technologies of high temperature and light water reactors. Gradual development of the concept is assumed in terms of the use of BGR-1000 for industrial and technological applications with a consistent increase of the core outlet coolant temperature.

The reactor design is based on the core with a fixed bed of coated microparticles made of different fuels and directly cooled by a longitudinally-cross flow of helium. The core design allows to have limited excess reactivity, exclude significant radiological consequences of accidents, provide the required level of fuel breeding and fuel reprocessing on the basis of best available practices, as well as, in the longer term, the closure of the fuel cycle with respect for all actinides.

Completed and planned studies are conducted in the following areas:

-choice of fundamental decisions for facility layout, design of the fuel and main equipment;

-optimization of the safety concept, including technical and economic analysis of the proposed safety solutions;

-formation of the in-reactor and external fuel cycle stages taking into account system requirements to a nuclear energy source;

-identification of critical technologies and design data needs;

-development of necessary R&D programs and experimental studies.

Country/Int. Organization

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