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Fast Neutron Reactors

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The question of alternative sources of energy is very relevant now. Humankind needs to reduce greenhouse gas and flue gas emissions to prevent global warming. Therefore, our project is dedicated to an alternative energy source in the form of a fast reactor. We touch upon basic principles of fast reactors and the reasons why this technology is considered useful and worth developing.

Breeder reactor technology was developed in the 1960s using demonstration and initial prototypes of reactors operating in several countries, including China, France, Germany, India, Japan, the Russian Federation, the United Kingdom and the United States. There are 12 experimental fast reactors and six commercial reactors from 250 to 1,200 MW that have been built or are in operation. The Russian Federation currently has the most powerful commercial fast reactor in operation, the BN-600 in Beloyarsk, and the BN-800 reactor is being constructed [1].

Initially, the FNR was designed to burn more efficiently and, as a consequence, to expand its uranium reserves - it could increase the number of reserves by about 60-65 times. From the very beginning, nuclear scientists understood that modern reactors operating only on U-235 produce less than one percent of the energy potentially available from uranium.

Fast reactors are a versatile and flexible technology that promises to create or "increase" fuel by converting nuclear "waste" into "fissile" material. The "fissile" material is nuclear fuel, usually uranium or plutonium, which can support the fission chain. The heat generated by this fission chain reaction, which is located in a nuclear power reactor, is used to generate steam, which is then fed into turbines to produce electricity. As fast reactors "burn" or consume material that would otherwise be considered "spent fuel", the total amount of nuclear material to be treated as waste is reduced.

Using currently known uranium resources, "closed-loop fast reactors can produce energy for thousands of years as well as solve waste problems," said Stefano Monti, head of the IAEA's fast reactor technology development team at the Department of Nuclear Energy.

The technology has already been introduced. It is based on a "closed fuel cycle", which means that spent fuel is recycled after it has been initially used in the reactor. Instead of sending spent fuel to storage and ultimately to long-term disposal, materials such as "fertile" material are reused. The "fertile" material is not decomposed, but can be converted to fissile material by radiation in the reactor. Once converted into fissile material, it will be consumed during the chain reaction [2].

The general principle of the reactor operation is as follows. Sodium is most often used as a coolant, because there should be no neutron retarders in the core. Sodium is also an excellent coolant. Substances like hydrogen and water (with light nuclei) are not allowed. Mercury is irrelevant due to its high corrosive activity. The pressure is slightly higher than atmospheric pressure, which makes the reactor safer. Uranium-235 and plutonium 239 fission occurs in the reactor core which is located in the reactor tank.

Sodium in the first circuit circulates through the core with temperatures from 350 to 550 degrees Celsius. The second circuit prevents sodium from entering the second and then the third circuits. Water in the third circuit boils and enters the turbine. Then the steam rotates the blades on the turbine rotor. The rotor is connected to another generator rotor, which generates current. The steam enters the condenser, where it is converted to water, for reuse or for plant purposes [3].

In conclusion, fast reactors can be used either to produce more fissile material than they consume or to burn nuclear waste. Or to combine these two tasks. In short, they offer significant advantages in terms of increasing the sustainability of nuclear power production.

References:

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