NUCLEAR FUEL FOR NUCLEAR REACTORS

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Nuclear power is not only nuclear power plants, but also a complex of enterprises that are needed to provide them with fuel. These are mines where uranium ore is mined, plants for its processing and the extraction of uranium oxide, enterprises where uranium isotopes are separated and fuel elements are created. After these elements with uranium are used at a nuclear power plant, they are transported to a plant where fission fragments and unburned fuel are separated from this used fuel. This cycle ends with the disposal or disposal of fission residues and other radioactive elements. The energy released as a result of the fission of heavy element nuclei in the reactor is removed from the reactor in the form of heat. Then the thermal energy is converted into another type of energy, which is necessary for an external consumer. The complex of equipment that ensures the operation of a nuclear reactor, the removal of thermal energy from the reactor and its conversion into another type of energy, constitutes a nuclear power plant (NPP). The medium that performs the work of converting thermal energy into mechanical energy is called the working fluid. For modern nuclear power plants, the working fluid is mainly water vapor. In the system of any nuclear power plant, the coolant passes through the nuclear reactor, removes heat from the reactor and transfers it to the working fluid. Currently, atomic energy is used mainly for the production of electricity. Uranium (U) or its compounds are used as natural nuclear fuel for nuclear reactors. Natural uranium contains three isotopes: ^{238}U, ^{235}U and ^{234}U. When irradiated with neutrons of any energy, only ^{235}U is divided. The probability of nuclear reactions significantly depends on the neutron energies (n). As the neutron energy decreases, the neutron wavelength increases, which leads to an increase in the interaction time of the neutron with the target nucleus and, accordingly, an increase in the momentum of the force of attraction between them. The main requirements for nuclear fuel are as follows: compatibility with reactor materials (primarily with the cladding material and coolant in the event of cladding depressurization); the ability to achieve a large burnup depth without significant changes in physical properties. As coolants in nuclear reactors, water (ordinary and heavy D_2O), gases, molten metals and, to a very limited extent, organic coolants are used. The main requirements for coolants are: ensuring sufficiently effective heat removal with moderate power consumption for circulation; compatibility of the coolant with the structural materials of the active zone and nuclear fuel; weak neutron absorption, and in fast neutron reactors - low moderating capacity; thermal and radiation stability, low activation (reduced radioactivity) of the coolant; availability and moderate cost.

It should be noted that all substances currently used as coolants only to a certain extent satisfy the above requirements. To satisfy the listed requirements, the choice of a particular coolant is made taking into account the properties of the structural materials of the core and the type of nuclear reactor.