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Nitride Fuel Fabrication: Technological Processes and Equipment

Uranium and plutonium mononitrides are considered as potential fuel for use in fast breeder reactors and high-temperature gas-cooled reactors. At the present time as a separate nuclear fuel is considered uranium (plutonium) carbonitride.
Revision of requirements that apply to fuel of economically competitive nuclear reactors of generation IV, and the desire for the largest possible compatibility of fabrication and reprocessing technologies of nitride fuel with fabrication and reprocessing technologies of oxide fuel makes nitride fuel rather perspective. This is conditioned by a number of significant advantages over other fuels, the most important of which is high density and high thermal conductivity. Nitrides can be produced at the same facilities as the oxides, without substantial modifications, and the initial stage of purex process for reprocessing of irradiated oxide fuel is applicable to nitride fuel.
During irradiation in nitride fuel radioactive isotope of carbon 14C is generated, which may complicate the of irradiated fuel elements reprocessing technology and radiation situation. Generation of carbon-14 under irradiation of nitride fuel can be substantially reduced by using of nitrogen which enriched with nitrogen-15 isotope.
The main directions in the development of nitride fuel fabrication processes are: nitriding of metallic uranium (plutonium); nitriding of uranium (plutonium) halides; carbothermic reduction of uranium (plutonium) dioxide in the presence of nitrogen and others. Currently these processes are underway when using of main reagent flow –nitrogen.
As a new direction in the development of nitride fuel fabrication processes is considered the using of closed volume and catalytic methods for nitriding of uranium (plutonium). Development of this approach allows to realize of economically expedient production of nitride fuel on the basis of Nitrogen-15.
In the report is considered in detail technological applications of the specified processes that allows to make up to (1.5-2.0) kg / h of the desired product and yield up to 99 % when the content of carbon and oxygen impurities up to 0.05 wt. % of each. Special attention is given to consideration of technological processes for fabrication of compact products from nitride (carbonitride) uranium (plutonium). Systemized data and equipment review for the technological sites for making of materials and products from nitride (carbonitride) uranium (plutonium) are presented.

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