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«II International Workshop on Advances in Materials Science – AMS-II - 2021»

«Multi-group modeling of radiation-protective properties of titanium hydride»

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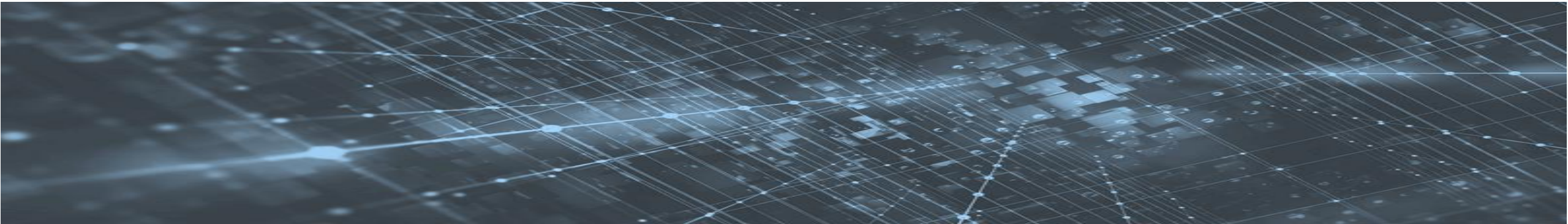
Problem statement

- Special concretes used for radiation protection of nuclear reactors do not provide the required protection efficiency.
- Materials based on titanium hydride meet the requirements of designers for the structural protection of fast neutron reactors.
- In order to determine the optimal conditions for using the structural radiation protection of a nuclear reactor, a comparative assessment of the protective properties of materials based on titanium hydride in relation to neutron and gamma radiation was carried out.

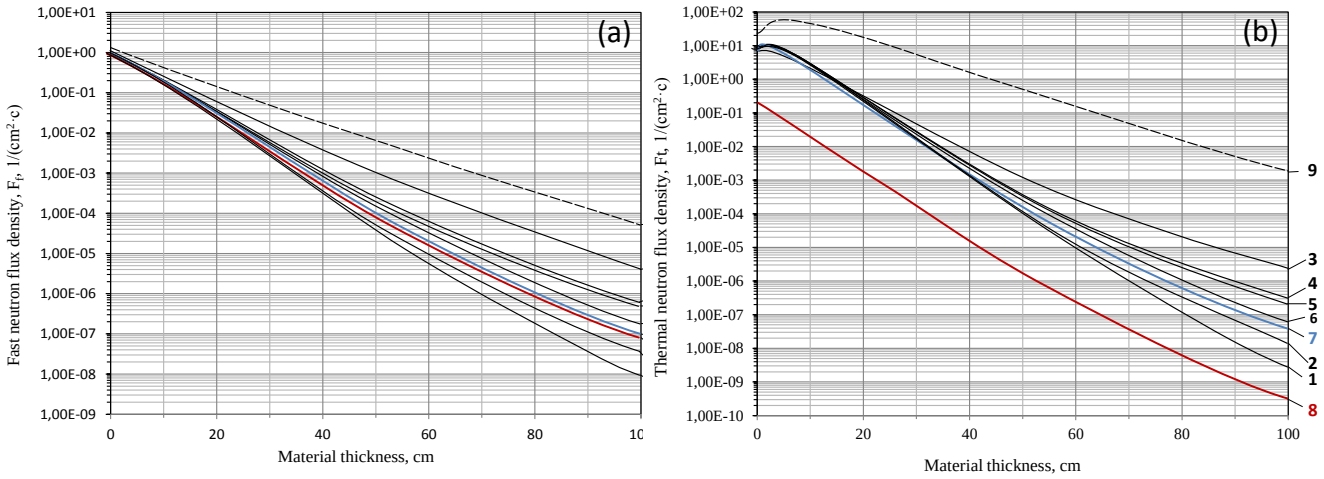


Solution methods

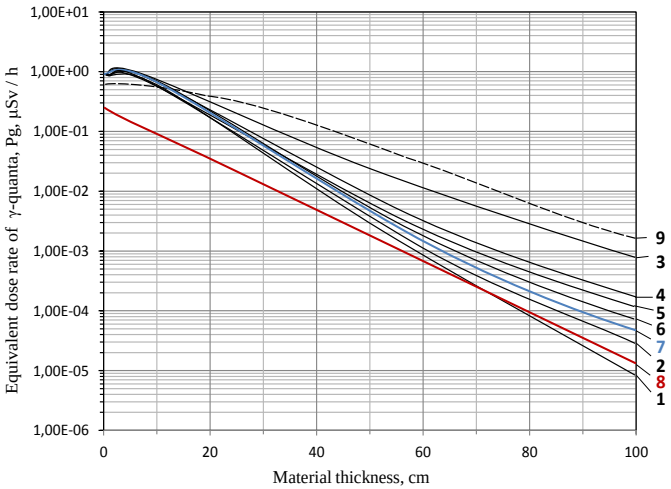
- The calculations of the main functionals characterizing the protective properties of materials were carried out by the method of multigroup modeling using the ANISN program.
- The neutron spectrum was calculated for a 22-group division of the energy interval, the gamma-radiation spectrum had an 18-group division.
- The distributions of the flux densities of neutrons and γ-quanta, as well as the distribution of the dose rate from neutrons and γ-quanta in the shielding materials were considered in plane geometry.

Conclusions

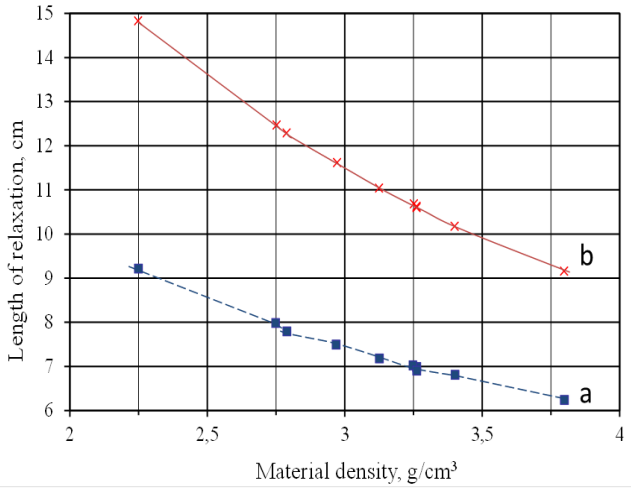
- Based on the carried out multi-group modeling, the high efficiency of titanium hydride is shown when it is used in the protection of nuclear power plants instead of serpentinite concrete.
- The introduction of boron atoms into the composite, which has a large neutron absorption cross section in the thermal and suprathermal spectral regions, reduces the effect of thermal neutron accumulation and the level of capture gamma radiation.
- The use of titanium hydride without a binder in the protection of shot is impractical due to the possibility of delamination, and the presence of free volume in the backfill significantly reduces the efficiency of material use.



Distribution of flux density of fast (a) and thermal (b) neutrons in shielding materials



The distribution of the equivalent dose rate of gamma quanta in materials



Change in the relaxation length of fast neutrons (a) and gamma quanta (b) depending on the density of the shielding material

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