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Reactor Pressure Vessel Steel Smart Behaviour as Cause of Instability in Kinetics of Radiation Embrittlement

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Abstract

Influence of neutron irradiation on reactor pressure vessel (RPV) steel degradation are examined with reference to the possible reasons of the substantial experimental data scatter and furthermore – nonstandard (non-monotonous) and oscillatory embrittlement behaviour. Data on radiation damage change including through the ex-service RPVs taking into account chemical factor, fast neutron fluence and neutron flux were obtained and analyzed. In our opinion controversy in the estimation on neutron flux on radiation degradation impact may be explained by presence of the wavelike component in the embrittlement kinetics. Therefore flux effect manifestation depends on fluence level. At low fluencies radiation degradation has to exceed normative value, then approaches to normative meaning and finally became sub normative. As a result of dose rate effect manifestation peripheral RPV’s zones in some range of fluencies have to be damaged to a large extent than situated closely to core. Moreover as a hypothesis we suppose that at some stages of irradiation damaged metal have to be partially restored by irradiation i.e. neutron bombardment. Nascent during irradiation nanostructure undergo occurring once or periodically evolution in a direction both degradation and recovery of the initial properties. According to our hypothesis at some stage(s) of metal nanostructure degradation neutron bombardment became recovering factor. So, material smart behaviour is a cause of instability in kinetics of radiation embrittlement of the reactor pressure vessel steel. As a result oscillation arise that in tern lead to enhanced data scatter. For the sake of correctness it is necessary to remember that there is an example when contrary to the famous radiation embrittlement in metals neutron irradiation at some range of fast neutron doses improving both the strength and ductility of steel take place. Foregoing hypothetical assumptions on “radiation annealing of the radiation embrittlement” and “material smart behaviour as cause of instability in kinetics of radiation embrittlement” are questionable and needs additional experimental verification and profound scientific study.

Biography:

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Speaker Publications:

1. Vibratory Processes in Vessel Steel Damage Kinetics in Nuclear Reactors; October 2017Atomic Energy 122(4); DOI: 10.1007/s10512-017-0283-3
2. Neutron Flux Density Effect on Vessel Steel Embrittlement; September 2017Atomic Energy 122(3):1-6; DOI: 10.1007/s10512-017-0275-3
3. Alloying of steel and graphite by hydrogen in nuclear reactor; February 2017IOP Conference Series Materials Science and Engineering 175(1):012050; DOI: 10.1088/1757-899X/175/1/012050

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