HYDROGEN GENERATION ARISING FROM THE ^{59}NI(N,P) REACTION AND ITS IMPACT ON FISSION-FUSION CORRELATIONS

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EXTENDED ABSTRACT

While the influence of transmutant helium on radiation-induced microstructural evolution has often been studied, there is a tendency to overlook the influence of concurrently-generated hydrogen. There have been some recent speculation and studies, however, that suggest that the influence of hydrogen may be enhanced in the presence of large amounts of helium, especially at lower irradiation temperatures typical of projected ITER operation.

In nickel-bearing alloys, one of the major sources of helium in some neutron spectra is the two-step ^{58}Ni(n,γ)^{59}Ni(n,)^{56}Fe reaction sequence. It now appears that another previously overlooked (n,p) reaction of ^{59}Ni can dominate the hydrogen production process in these same neutron spectra. Whereas the ^{59}Ni(n,)^{56}Fe reaction has a thermal cross-section of 12.3 barns, the ^{59}Ni(n,p)^{59}Co reaction has a thermal cross-section of 2.0 barns, generating approximately one hydrogen atom for each six helium atoms.

Both the (n,) and (n,p) reactions are highly exothermic, producing 4.76 MeV alpha particles and 1.82 MeV protons, traveling 9.5 and 15.7 m, respectively, in stainless steel. Since these ranges greatly exceed the scales of both radiation-induced segregation and microstructural inter-sink distances, there is essentially no measurable influence of nickel segregation on the distribution of either transmutant. There will be some local enhancement of the displacement damage from recoil of the ^{56}Fe and ^{59}Co atoms, however. Inclusion of the damage energy deposited by the (n,p) reaction in the alloy matrix, however, requires that a ^{59}Ni(n,) damage enhancement formula published earlier be only slightly revised ($\sim$4%) to incorporate the concurrent effect of the (n,p) reaction.

The impact of the (n,p) reaction on both hydrogen generation rates and displacement rates are evaluated in this paper for a variety of neutron spectra employed in fission-fusion correlation.

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