A REVALUATION OF HELIUM/DPA RATIOS FOR FAST REACTOR AND THERMAL REACTOR DATA IN FISSION-FUSION CORRELATIONS - FA Garner and LR Greenwood (Pacific Northwest National Laboratory), BM Oliver (Rockwell International Corporation)

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EXTENDED ABSTRACT

For many years it has been accepted that significant differences exist in the helium/dpa ratios produced in fast reactors and various proposed fusion energy devices. In general, the differences arise from the much larger rate of (n,α) threshold reactions occurring in fusion devices, reactions which occur for energies $\geq$ 6 MeV. It now appears, however, that for nickel-containing alloys in fast reactors the difference may not have been as large as was originally anticipated. In stainless steels that have a very long incubation period for swelling, for instance, the average helium concentration over the duration of the transient regime have been demonstrated in an earlier paper to be much larger in the FFTF out-of-core regions than first calculated.

The helium/dpa ratios in some experiments conducted near the core edge or just outside of the FFTF core actually increase strongly throughout the irradiation, as ^{59}Ni slowly forms by transmutation of ^{58}Ni. This highly exothermic ^{59}Ni(n,α) reaction occurs in all fast reactors, but is stronger in the softer spectra of oxide-fueled cores such as FFTF and weaker in the harder spectra of metal-fueled cores such as EBR-II. The formation of ^{59}Ni also increases strongly in out-of-core unfueled regions where the reactor spectra softens with distance from the core.

In this paper measurements of helium concentrations are presented for a variety of Fe-15Cr-XNi ternary alloys irradiated in EBR-II to in-core doses ranging from 76 to 131 dpa. Within the core the measured helium levels are consistent with nickel being the dominant contributor and are also consistent with the operation only of the (n,α) high energy threshold reactions. The ^{59}Ni contribution is only important far from the EBR-II core. While significant amounts of fusion-relevant data were generated out-of-core in FFTF, very little useful data for fusion purposes was generated outside the EBR-II core.

In addition, there has been a tendency to overlook the concurrent generation of hydrogen by the ^{59}Ni(n,p) reaction which is also highly exothermic. Estimates have been made of the hydrogen arising from various neutron spectra. The impact of this (n,p) reaction on calculation of displacement damage and the development of fission-fusion correlations is also discussed.

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