**THE DEPENDENCE OF HELIUM GENERATION RATE ON NICKEL CONTENT OF Fe-Cr-Ni ALLOYS IRRADIATED AT HIGH DPA LEVELS IN FAST REACTORS -**

F. A. Garner, B. M. Oliver and L. R. Greenwood (Pacific Northwest National Laboratory, Richland, WA)

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**Extended Abstract**

With a few exceptions in the literature, it is generally accepted that it is the nickel in Fe-Cr-Ni alloys that produces most of the transmutant helium and that the helium generation rate should scale linearly with the nickel content. Surprisingly, this assumption is based only on irradiations of pure nickel and has never been tested in an alloy series. There have also been no extensive tests of the predictions for helium production in alloys in various fast reactor spectra.

Nickel can contribute to helium production via high neutron energy (n,$\alpha$) reactions with the various naturally-occurring nickel isotopes or by reactions at low-neutron energies with the radioactive isotope $^{59}$Ni produced from the $^{58}$Ni (n,$\gamma$) reaction, which also occurs at low neutron energies. The latter sequence is strongly dependent on neutron spectra and irradiation time, reflecting the burn-in of the $^{59}$Ni.

This paper presents the results of two sets of irradiations in different fast reactors to measure directly the influence of nickel on helium production and our ability to predict such production. The first series were irradiated in a variety of in-core and out-of-core positions in FFTF over a range of dose (0.2-50 dpa) and spectral conditions, yielding different balances of helium formed by the low energy and high energy neutron reactions. The second series were irradiated simultaneously throughout the axial height of the EBR-II core to doses ranging from 76 to 131 dpa. Since the in-core spectra in EBR-II is significantly harder than that of FFTF, the helium production due to the $^{59}$Ni sequence was found to be negligible in this second series, in spite of the high dose levels attained.

The alloys used in the FFTF series were Fe-15.0Cr-25.0Ni and Fe-15.0Cr-45.0Ni, while those in the EBR-II series were Fe-15.6Cr-15.7Ni, Fe-15.0Cr-45.3Ni and Fe-14.6Cr-75.1Ni. In irradiations conducted in a truly side-by-side manner, the helium generation was found to be linearly proportional to the nickel content as expected. If there existed even minor differences in position and spectra of specimens with different nickel levels, however, the proportionality is not as good, reflecting the strong spectral sensitivity of the $^{59}$Ni (n,$\alpha$) reaction. The latter situation sometimes occurred in the FFTF irradiation series where different alloys were placed in adjacent packets, especially in out-of-core regions where spectral variations are more pronounced.