**ACCELERATED HELIUM AND HYDROGEN PRODUCTION IN $^{54}$FE DOPED ALLOYS - MEASUREMENTS AND CALCULATIONS FOR THE FIST EXPERIMENT -** L. R. Greenwood and B. M. Oliver (Pacific Northwest National Laboratory)*, S. Ohnuki (Hokkaido University, Japan), K. Shiba (Japan Atomic Energy Research Institute), Y. Kohno (University of Tokyo, Japan), A. Kohyama (Kyoto University, Japan), J. P. Robertson (Oak Ridge National Laboratory), J. W. Meadows (Argonne National Laboratory) and D. S. Gelles (Pacific Northwest National Laboratory)*

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## ABSTRACT

Helium analyses of natural iron samples previously irradiated in HFIR indicated a non-linear buildup of helium suggesting accelerated helium production due to isotopic shifts between the iron isotopes. This effect was ascribed to isotopic transmutation since the isotopic gas production cross sections vary significantly. In order to study these isotopic differences in helium and hydrogen production, iron alloys enriched in $^{54}$Fe were fabricated in Japan . The F-82H alloy nominally consisted of 8Cr-2WVTa. $^{54}$Fe in the alloy comprised 96% of the iron or 86% of the total alloy by weight. For comparison, similar alloys were produced both with natural iron and with natural iron doped with varying amounts of boron.

Helium and hydrogen measurements were performed for samples irradiated in the JP-17 and JP-22 experiments in HFIR. The results are compared to calculations using isotopic helium production cross sections from ENDF/B-VI or the computer code, GNASH, for the radioactive isotope $^{55}$Fe. Neutron dosimetry results were used to determine the neutron spectra. Helium measurements demonstrated an accelerated helium (appm)/dpa ratio of 2.3 after a 1.25-year irradiation, an increase of a factor of 4.3 over natural iron. The accelerated helium production is due to higher helium production cross sections for $^{54}$Fe and $^{55}$Fe. Alloys doped with $^{55}$Fe could achieve helium/dpa ratios up to about 20, well above the fusion reactor ratio of 10. Hydrogen measurements were performed using a newly developed quadruple mass spectrometer system at PNNL capable of detecting 5-appm hydrogen in milligram-sized irradiated specimens. Calculations predict that hydrogen production will be accelerated by about a factor of 13 over natural iron. However, measurements show that most of this hydrogen is not retained in the samples.

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