

CALCULATION AND MEASUREMENT OF HELIUM GENERATION AND SOLID TRANSMUTANTS IN Cu-Zn-Ni ALLOYS - L. R. Greenwood, B. M. Oliver, and F. A. Garner (Pacific Northwest National Laboratory)* T. Muroga (National Institute of Fusion Science, Nagoya 464-01, Japan)

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EXTENDED ABSTRACT

A method was recently proposed by Garner and Greenwood that would allow the separation of the effects of solid and gaseous transmutation for Cu-Zn-Ni alloys. Pure copper produces zinc and nickel during neutron irradiation. ^{63}Cu transmutes to ^{64}Ni and ^{64}Zn , in about a 2-to-1 ratio, and ^{65}Cu transmutes to ^{66}Zn . The ^{64}Zn further transmutes to ^{65}Zn which has been shown to have a high thermal neutron (n,α) cross-section. Since a three-step reaction sequence is required for natural copper, the amount of helium produced is much smaller than would be produced for the two-step, well-known $^{58}\text{Ni}(n,\gamma)^{59}\text{Ni}(n,\alpha)$ reaction sequence. The addition of natural Zn and Ni to copper leads to greatly increased helium production in neutron spectra with a significant thermal component. Using a suitable Cu-Zn-Ni alloy matrix and comparative irradiation of thermal neutron-shielded and unshielded specimens, it should be possible to distinguish the separate influences of the solid and gaseous transmutants.

Whereas helium generation rates have been previously measured for natural nickel and copper, they have not been measured for natural Zn or Cu-Ni-Zn alloys. The (n,α) cross section for ^{65}Zn was inferred from helium measurements made with natural copper. By comparing helium production in Cu and Cu-Zn alloys, this cross section can be determined more accurately. In the current study, both the solid and helium transmutants were measured for Cu, Cu-5Ni, Cu-3.5Zn and Cu-5Ni-2Zn, irradiated in each of two positions in the HFIR JP-23 test. Highly accurate helium measurements were performed on these materials by isotope dilution mass spectrometry using a facility that was recently moved from Rockwell International to PNNL.

It is shown that both the helium and solid transmutants for Cu-Zn-Ni alloys can be calculated with reasonable certainty, allowing the development of a transmutation experiment as proposed by Garner and Greenwood.

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