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A Survey of Experimental and Evaluated Fast Neutron Helium Production Cross Section Data for Fusion Energy Applications [a]

by

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Abstract

It is well established that the high fluences of fast neutrons likely to be encountered in the environments of fusion reactors or fusion materials test facilities will generate substantial quantities of helium (both ^{4}He and ^{3}He isotopes), and that the presence of this gas in bulk material can produce serious damage in engineering structures due to swelling. The present study was undertaken to survey the current status (as of early 2004) of the available fast neutron cross section information for helium production in several major structural elements of interest for the development of fusion energy systems. The scope of this study encompasses both compiled experimental cross section data and evaluated cross sections available from major nuclear data libraries used in the analysis of fusion systems. The main conclusion from this work is that the contemporary knowledge of those individual neutron reaction cross sections important for helium production is, in general, very inadequate for the purpose of producing reliable designs for fusion reactors (e.g., ITER) and materials irradiation test facilities (e.g., IFMIF). Since the number of distinct neutron reactions that must be considered is large, and the capabilities (both experimental and theoretical) of the nuclear physics community to adequately determine the cross sections for specific reactions is limited for various reasons, it is recommended, as a consequence of the present investigation, that an engineering approach be undertaken to provide the data needed for system design purposes. The suggested technical approach would involve irradiating small specimens of candidate materials in high fluence neutron fields whose spectra resemble as closely as possible those to be encountered in real fusion facilities, and that direct integrated yield measurements then be made of helium production in these samples, inclusive of all the contributing neutron reaction channels.

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