

Gas Production in the Proton Beam Window and Target Vessel at SNS

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Due to its profound effects on the microstructure, void swelling and embrittlement of structural materials, the transmutation gas production of hydrogen and helium is an important metric in evaluating radiation damage on structural materials in a spallation facility. A systemic measurement of gas productions at the proton beam window (PBW) and mercury target vessel at SNS is underway. Detailed calculations were carried out in preparation for the measurements for an Al-6061 and Inconel 718 PBW and a SS316L target vessel. To accurately predict gas production at different locations of the PBW and target vessel, incident proton beam profile and direction distributions at the PBW were carefully constructed from the real time measurements of proton beam distributions at a harp located at 7.2 m upstream of the PBW. The resulting proton beam at the PBW is thus a time-averaged beam profile with a distribution of beam directions at each pixel of the profile over the operation time of the PBW or target vessel. New hydrogen and helium production cross sections were developed to include cross sections for each gas isotope, instead of for each gas element as used in the current cross section library. In such a way, the calculated gas productions will be better checked by a mass spectroscopy based experimental method capable of distinguishing each gas isotopes. Recent versions of both CEM and INCL4 intra-nuclear cascade (INC) models were used in generating this new set of hydrogen and helium production cross sections. The differences in these cross sections are discussed, although the main purpose of using different INC models was to compare and benchmark them with the planned measurements in the near future.

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