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PETALE stainless-steel transmission experiments in CROCUS: feedback on INDEN evaluations

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The CEA-EPFL PETALE program on stainless steel and its elements took place at the end of 2020 in the CROCUS reactor at EPFL. The program consists of 21 experiments in transmission, in which the neutron flux in the reflector was measured through activation dosimetry (115In(n,g), 197Au(n,g), 115In(n,n'), 58Ni(n,p), 54Fe(n,p), 56Fe(n,p), and 27Al(n,a)), and 5 reactivity worth experiments, one per reflector –stainless steel 304L, chromium, nickel, and iron –as well as water. The high-fidelity analysis is now reaching its conclusion, and the Benchmarking is now funded and starting.
This presentation focuses on the transmission experiments, includes the last troubleshooting performed during the analysis of the results, and presents the observed differences in the C/E respectively to the distance in the reflectors, between the current official JEFF release (JEFF-3.3) and the new evaluations of INDEN. It is now confirmed that the previously presented discrepancies between the results from Serpent2 and Tripoli-4®, for the fast neutron sensitive dosimeters with the Chromium reflector, are due to unexpected definitions in the MT5 and MF6 that our Serpent2 build has trouble interpreting. This issue is solved by using JEFF-3.1.1 for these cases. Additionally, the common drop observed at the end of the reflectors in the C/E of 56Fe(n,p) dosimeters, is attributed to the presence of around 6 ppm of 55Mn in the dosimeters. These impurities activate into the same product as the dosimeter by radiative capture. It results in a contribution of up to 20% of a dosimeter's total activity.
In the case of the trends, the observed results show that the new evaluation for iron performs significantly better than JEFF-3.3 for the 115In(n,n') and 58Ni(n,p) fast neutron dosimeters. The previous evaluation shows an increase in the C/E respectively to the increase in reflector thickness, while the INDEN evaluation presents a flat profile. At higher Energy (56Fe(n,p) and 27Al(n,a)) the increase in the C/Es respectively to the thickness is preserved. With the non-threshold capture dosimeters (115In(n,g) 197Au(n,g)), in which the median energy of activations is in the eV range, the good agreements are preserved. Similarly, the new evaluation performs better in the 115In(n,n') and 58Ni(n,p) dosimeters range for the 304L reflector. At higher energy (56Fe(n,p)) the observed increase in C/E is slightly reduced, offering a better agreement, while in the low energies, the good agreement is preserved. In the case of the chromium, a gradual decrease of the C/E is observed for the 115In(n,g) and 197Au(n,g) dosimeters, resulting in a slightly worse comparison to the experiments respectively JEFF-3.3. The results with 115In(n,n') dosimeters are slightly closer to the experimental results but a strong decrease in the C/E is still visible. At higher energy, INDEN and JEFF-3.1.1 show similar results, a downward trend for 58Ni(n,p), and upward trends for both 56Fe(n,p) and 27Al(n,a). In the case of the nickel reflector, which INDEN does not currently re-evaluate, TENDL-24 shows similar results to JEFF-3.3 in the fast region, with an especially strong downward trend for the 115In(n,n'). In the lower energies, the results degraded considerably, with a new upward trends in the reflectors and sharp drops in the C/E on both sides of the reflector.
Pile-oscillation of samples cut from the spare sheets of the reflectors are currently running and will be analyzed in parallel with PETALE's reactivity worth experiments

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