An ADS irradiation facility for fast and slow neutrons

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Abstract

We studied a flexible ADS based irradiation facility with fast neutrons inside the core and slow neutrons in the composite light reflector. A fast reactor core has been studied using MCNP-6 code [1] with a mixed reflector formed by three concentric cylindrical layers (lead+graphite+lead) in order to have different neutron spectra to perform various types of measurements without perturbing the ADS core fast characteristics.
We also included in the ADS design three irradiation channels with different neutron spectra to perform measurements out of the reactor. We simulated different kinds of measurements to be performed in different positions, in the core, in the reflector and using the irradiation channels.
Starting from the previous design of a low-power, solid lead-based ADS system, fueled by UO_2 (20% U-235), helium-cooled, with thermal power of 200 kW [2], intended for research, education and training purposes, we studied a possible modification of this system in order to make this machine a more flexible irradiation facility. We maintained a similar core structure, substituted the fuel with a more common MOX (22% Pu+Am [3]), replaced helium with water as coolant and the pure lead reflector with a composite one, formed by alternate lead and graphite [4]. The source intensity is about 8×10^{14} neutrons/sec and comprises a proton beam colliding on a beryllium target at the center of the core system [5].
In table 1, we report the integral fluxes values, the percentage of the flux over 0.5 MeV and the ratio R between the percentage of flux above 0.5 MeV and the percentage below 1 eV, for 3 core positions, CP1, 2, 3, from closest to the source to farthest from the source.

Table 1: Integral flux, percentage of Φ> 0.5 MeV and R values for the in-core irradiation positions.

Position	Integral flux (n/cm^2/s)	% Φ>0.5 MeV	R
CP1	1,12E+13	38	5.96E+2
CP2	7.25E+12	37	3.71E+2
CP3	4.36E+12	33	1.75E+2

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In Table 2, we report the integral flux values and the relative percentage below 1 eV, for 3 positions in the reflector graphite shell, RP1, 2, 3, from closest to the core to farthest from the core.

Table 2: Integral flux and % of Φ< 1eV values for the out-core irradiation positions

Postion	**Integral flux (n/cm^2/s)**	**% Φ< 1 eV**
RP1	1,85E+12	40.42
RP2	8.48E+11	83.97
RP3	3,87E+11	95.77

We simulated, using MCNP-6 and MCB [6] codes, some examples of possible gamma spectroscopy measurements in different positions in.core, (CP1) out-core (RP1) and using the irradiation channels (IC2) in order to have different neutron spectra and various conditions. We considered some examples of irradiation of Medium Lived Fission Products (MLFP), Long Lived Fission Products (LLFP) and Minor Actinides (MA). Finally, we studied the effect of a simple reactor shielding and performed a preliminary thermal-hydraulics analysis of the system.

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