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P2.164 ARC reactor: Activation analysis of the liquid blanket and structural materials for the vessel

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Nowadays, Fusion Energy is one of the most important sources under study. During the last years, different designs of fusion reactor were considered. At the MIT, an innovative design was created: ARC, the Affordable Robust Compact reactor. It takes advantage of the innovative aspect of recent progress in fusion technology, such as High Temperature Superconductors, that permit to decrease the dimension of the machine, reaching at the same time high magnetic fields.
Our main goal is the low-activation analysis of possible structural materials for the vacuum vessel, which is designed as a single-piece placed between the first-wall and the tank that contains the breeding blanket. Due to its position, the vacuum vessel is subject to high neutron flux, which can activate it and cause the reduction of the component lifetime and decommissioning problems. The activation analysis was done also for the liquid breeder FLiBe, compared with Lithium-Lead. Codes used for the low-activation analysis were MCNP and FISPACT-II. The first one is based on a neutronic model and for each component a certain neutron flux is evaluated. For FISPACT-II, the main input is the composition of the analyzed material, the neutron flux and the irradiation time. Results from FISPACT-II are the time behavior of Specific Activity, contact Dose Rate, and Decay Heat. To choose the best structural material for the vacuum vessel, both mechanical and low-activation properties were considered. Vanadium alloys turn out to be one of the best alternatives to the present material, Inconel-718. Finally, Isotopic Tailoring and Elemental substitution methods were applied. Here, the composition of each alloy is analyzed and critical isotopes or elements are eliminated or reduced. After the modifications, new simulations are done, and those leading to significant improvements in the final results are highlighted.

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