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P4.178 Development of a computational procedure to simulate activation of coolant/breeding loops in DEMO reactors

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In future fusion DEMO reactors, coolant and breeding materials will flow along loops experiencing very different neutron irradiation environments, from those corresponding to in-vessel systems like blankets and divertor, up to regions without significant neutron radiation farther from the reactor. Moreover, in these loops there are material extractions due to the functioning of the tritium extraction and purification systems as well as release/deposition of activation corrosion products. In these circumstances, the time evolution of the nuclide inventory in the fluids will depend on both irradiation history and material injection/extraction. A reliable prediction of this nuclide inventory evolution in the loops is a mandatory task for maintenance, safety and waste management analysis, as can be the most relevant radiation source in regions beyond the bioshield.

The aim of this work is to present a computational procedure to estimate the nuclide inventory evolution in this kind of loops. Such procedure is capable to simulate realistic irradiation conditions of the flowing materials, considering different spatial regions or blocks with the corresponding neutron spectra and residence times. In addition, the nuclide inventory can be modified at the entrance/exit of each block in order to simulate the abovementioned material injections and extractions.

The neutron fluxes used in the procedure are calculated by the MCNP5 transport code while the activation is carried out by the ACAB code. The coupling of these codes is managed by a script that joins the different blocks considered for the loop. In addition, because of the long computational time required for the simulation of the huge number of loops expected in DEMO, an extended effort has been done for computational optimization of the activation calculations based on the reduction of the rate equation matrix.

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