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P2.172 The production and molecular occurrence of radiotoxic Po-210 in liquid Pb-Li tritium breeding blankets

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To be accepted in the future energy landscape, fusion reactors must be inherently safe by design. An unresolved safety issue is the undesired production of highly radiotoxic Po-210 in the liquid Pb-Li eutectic used in many breeding blanket concepts. Po-210 is the end product of consequent neutron captures and beta decays, initiated by a neutron capture by Pb-208.

Po-210 is an intense alpha emitter, having a median lethal dose of only 0.089 micrograms. To ensure the safe operation of a fusion reactor, the inventory build-up of Po-210 should be monitored over the lifetime of the reactor. Therefore, 3D Monte Carlo neutron transport calculations were performed using the MCNP code for realistic DEMO reactor models, developed by the Power Plant Physics and Technology programme. Two blanket concepts based on the use of Pb-Li were considered: the Helium Cooled Lithium Lead and the Water Cooled Lithium Lead blankets. The obtained neutron fluxes were coupled to the FISPACT-II code to determine the time-dependent Po-210 inventory. Both conservative and more realistic estimations were determined by using different DEMO models, nuclear data libraries and initial Bi impurities in the Pb-Li.

If the Po-210 inventory becomes too high, filtering techniques must be applied. To devise efficient filtering systems, the molecular composition and aggregation state of the Po-210 have to be determined. We focused on the properties of Po-containing gaseous molecules, as these can escape from the reactor most easily. As experiments with volatile Po species are subject to severe safety restrictions, few experimental data is available. An alternative quantum chemistry approach with the MOLCAS code was used to predict the stability of all relevant diatomic Po-containing molecules. Using experimental data on lighter analogue molecules, the reliability of the method was assessed. Finally, the relative occurrences of the different Po species for realistic operational conditions was estimated.

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