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PbLi Activation Due to Corrosion Products in WCLL BB (EU-DEMO) and Its Impact on Reactor Design and Recycling

Authors : Nicole Virgili, Marco Utili

Abstract : The design of the Breeding Blanket in Tokamak fusion energy systems has to guarantee sufficient availability in addition to its functions, that are, tritium breeding self-sufficiency, power extraction and shielding (the magnets and the VV). All these function in the presence of extremely harsh operating conditions in terms of heat flux and neutron dose as well as chemical environment of the coolant and breeder that challenge structural materials (structural resistance and corrosion resistance). The movement and activation of fluids from the BB to the Ex-vessel components in a fusion power plant have an important radiological consideration because flowing material can carry radioactivity to safety-critical areas. This includes gamma-ray emission from activated fluid and activated corrosion products, and secondary activation resulting from neutron emission, with implication for the safety of maintenance personnel and damage to electrical and electronic equipment. In addition to the PbLi breeder activation, it is important to evaluate the contribution due to the activated corrosion products (ACPs) dissolved in the lead-lithium eutectic alloy, at different concentration levels. Therefore, the purpose of the study project is to evaluate the PbLi activity utilizing the FISPACT II inventory code. Emphasis is given on how the design of the EU-DEMO WCLL, and potential recycling of the breeder material will be impacted by the activation of PbLi and the associated active corrosion products (ACPs). For this scope the following Computational Tools, Data and Geometry have been considered: • Neutron source: EU-DEMO neutron flux < 1014/cm2/s • Neutron flux distribution in equatorial breeding blanket module (BBM) #13 in the WCLL BB outboard central zone, which is the most activated zone, with the aim to introduce a conservative component utilizing MNCP6. • The recommended geometry model: 2017 EU DEMO CAD model. • Blanket Module Material Specifications (Composition) • Activation calculations for different ACP concentration levels in the PbLi breeder, with a given chemistry in stationary equilibrium conditions, using FISPACT II code. Results suggest that there should be a waiting time of about 10 years from the shut-down (SD) to be able to safely manipulate the PbLi for recycling operations with simple shielding requirements. The dose rate is mainly given by the PbLi and the ACP concentration (x1 or x 100) does not shift the result. In conclusion, the results show that there is no impact on PbLi activation due to ACPs levels.

Keywords : activation, corrosion products, recycling, WCLL BB., PbLi
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