

Spallation Target design for J-PARC Transmutation Experimental Facility

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Japan Atomic Energy Agency (JAEA) has been researching and developing an accelerator-driven system (ADS) [1] as a dedicated system for the transmutation of long-lived radioactive nuclides. The ADS proposed by JAEA uses lead-bismuth eutectic (LBE) as a target material and a coolant. In the various R&D for ADS, construction of the Transmutation Experimental Facility (TEF) is planned under the framework of the J-PARC project as a preceding step before the construction of demonstrative ADS. In TEF, the ADS target test facility (TEF-T) is aimed at the acquisition of materials irradiation data. The beam window (BW) of TEF target functioning as the primary barrier between LBE and the external environment will be exposed to the serious condition induced by the proton beam. Therefore, the feasibility of the BW is the most important factor for the realization of TEF. In the evaluation of structural integrity of BW, the estimation of thermal-fluid properties of the flowing LBE is an important essence, because it closely to the heat removal of BW. The objective of this study is to evaluate the feasibility of a designed BW of TEF target by the numerical analysis with a 3D model.

In the typical case, the peak current density and the profile of the proton beam were set to 20 $\mu\text{A}/\text{cm}^2$ and a Gaussian shape, respectively. The flow rate of LBE and temperature at the inlet were 1 ℓ/sec and 350 $^{\circ}\text{C}$. In this case, the maximum velocity of LBE and the maximum temperature located at the top of the BW were about 1.2 m/sec and 477 $^{\circ}\text{C}$. The maximum shear stress was 190 MPa, which was observed at the center on the outside surface of a beam window. The value of analyzed stress was lower than the tolerance level of the stress strength of the material given by the legal limitation which is applied to the fast reactor [2]. In the evaluation of the repeated stress, it was confirmed to be a permission level and hence the feasibility of a designed beam window was confirmed.

References

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