IMPROVEMENT OF IFMIF/EVEDA BAYONET CONCEPT BACK-PLATE DESIGN

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In the frame of the Engineering Validation and Engineering Design Activities (EVEDA) phase of the International Fusion Materials Irradiation Facility (IFMIF) project, a supporting lithium loop has been designed and is currently under construction at Oarai (Japan) with the main objective to test several technological solutions to be adopted in the future IFMIF plant. Among these, the lithium target system represents one of the most critical components as it will be exposed to high-energy intense neutron flux and consequently to severe irradiation damage rates (up to 50 dpa/fpy). For this reason, it must be designed for periodic replacement. The solution proposed by ENEA is based on the so-called back-plate bayonet concept which consists in a replaceable back-plate that can be inserted to and removed from the permanent structure of the target assembly by means of a sliding-skate mechanism. A preliminary prototype was designed, manufactured and successfully tested in the past at the ENEA Brasimone research centre in order to demonstrate the feasibility of such concept. In this first design, the force required to ensure the tightness between the permanent structure and the removable back-plate was provided by three skates mounted in the lower, upper and lateral side while in the remaining side the closing thrust was exerted by bolts. Insertion/removal operations of the back-plate were accomplished by sliding it laterally. The lithium channel profile was made up of two straight sections connected to a central, constant-curvature region at the footprint level.

Recently, the design of the bayonet back-plate has been revised and some important modifications have been introduced in order to improve its functionality and optimize its features in terms of compactness, robustness and remote maintainability. The new design foresees the adoption of only two lateral skates which allow for the positioning of the back-plate from the top along the vertical direction. Several design solutions have been conceived to achieve better performances including smaller overall dimensions, sealing load reduction, gasket retention improvement, more effective positioning/alignment system, detachment mechanism for removal operation and optimized design of the interface frame. Moreover, a new variable-curvature geometry for the lithium channel profile has been calculated using an analytic approach based on the simplified Navier-Stokes equations in order to avoid the detachment of the flow and the fluid-dynamic instabilities evidenced in the old profile. A careful choice of materials for the various components of the system are made to fulfil design constraints and fabrication requirements. To assess the mechanical behaviour of the new design, a complete thermo-mechanical analysis is carried out using an integrated model for the whole target assembly. Additionally, neutronic calculations are performed to evaluate irradiation conditions such as damage rate, gas production and heat deposition in the material. In this paper, the new design features of the back-plate are presented, along with the main outcomes obtained from the numerical assessment performed.