EVALUATION OF THE TUNGSTEN ALLOY VAPORIZING LITHIUM FIRST WALL AND BLANKET CONCEPT*

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To achieve high thermal performance at high power density, the EVOLVE W-alloy FW/blanket concept proposes to use transpiration cooling of the first wall and boiling or vaporizing lithium in the blanket zone leading to a lithium vapor outlet temperature of 1200 degree C. While maintaining at the saturation pressure of 0.028–0.17 MPa, this high lithium outlet temperature leads to a helium closed cycle gas turbine efficiency of approximately 57%. For this phase of the EVOLVE concept evaluation, we focused on addressing critical issues. For the transpiration cooled first wall design, we determined the characteristic dimensions of the lithium first wall flow channels and the capillary openings for lithium vaporization. The basic design criterion is that the capillary pressure must overcome the sum of all frictional and MHD pressure losses. We found that a reasonable design is to have a first wall tube diameter of about 6 cm, a lithium channel width of about 2 mm and a capillary opening of 0.5 mm. For the blanket design, two approaches were evaluated. The first approach is to hold the fluid lithium in horizontal trays. The lithium is allowed to boil and the vapor is routed with the first wall vapor to the lithium/helium heat exchanger. Using the drift flux model and considering the churn-turbulent boiling regime, the generation of Li-vapor was determined as a function of location in the lithium tray. Initial results show a large void fraction of up to 65%. The impact on the overall tritium breeding ratio and required radial build was found to be minimum. The second option is an extension of the FW transpiration-cooling concept. The lithium slabs in the blanket are held in walls with capillary openings. The characteristic dimensions are then determined based on the

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superheating of the lithium. There is no lithium boiling or bubble formation with this approach. We also evaluated the integrated and separated FW and blanket configuration options. With the separate FW option, welding between FW and the trays are minimized but the impact of the additional wall on afterheat removal has to be investigated. The other critical area of the EVOLVE concept is the fabrication of W-alloy components, and initial findings will be summarized in this paper. This paper will also summarize the results on the development and evaluation of critical issues of the EVOLVE design. Necessary development on this innovative high performance high power density FW/blanket system will also be presented.