

MODULAR DUAL COOLANT PB-17LI BLANKET DESIGN FOR ARIES-CS COMPACT STELLARATOR POWER PLANT

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The ARIES-CS program consists of a three-phase effort that will result in the detailed design study of a compact stellarator power plant. The first phase of the ARIES-CS engineering study was focused on scoping out different compact stellarator design configurations and maintenance schemes to identify the key issues and better understand the parametric design window and the engineering constraints associated with different designs and maintenance schemes. This led to a down selection to a couple of most attractive combinations of blanket configuration and maintenance scheme for more detailed studies during the second phase of the study. The preferred blanket concept is a dual coolant blanket with He-cooled ferritic steel FW/blanket structure and a self-cooled Pb-17Li breeding zone with SiC_f/SiC flow channel inserts serving as electrical and thermal insulator. An advanced self-cooled Pb-17Li concept with SiC_f/SiC as structural material is maintained as a higher performance, higher risk back-up option. The selected maintenance schemes include both a field-period-based maintenance approach and a modular maintenance approach with replacement of smaller modules through a number of selected ports.

This paper summarizes the results from the engineering effort during the second phase of ARIES-CS study on the conceptual design of the dual coolant blanket modular concept. The typical size of the blanket modules is about 2 m (tor.) x 2 m (Pol.) x 0.6 m (rad.) in order to be compatible with modular replacement through a small number of designed maintenance ports using articulated booms. The overall layout of the blanket module including the He coolant and Pb-17Li flow paths and the attachment of the blanket modules to the coolant manifold behind the blanket (including the mechanical connections and the methods for cutting/re-welding of the coolant access tubes) are described. Results of the supporting thermal hydraulic analyses of such a blanket coupled to a Brayton cycle are presented and discussed. Key issues are highlighted and an initial assessment of the suitability and attractiveness of such a concept for a compact stellarator is summarized.