EVOLVE Lithium Tray Boiling Analysis

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In order to achieve high power density and high power conversion efficiency, in future fusion reactor designs, several features are required from the first wall and blanket. High power density means the coolant heat removal must be significant and high power conversion implies that the first wall and blanket must operate at high temperatures. First wall material must have high thermal conductivity and low thermal stress, which leads to a high temperature refractory alloy such as tungsten. Because of limited material strength, at high temperature, operating pressure should be minimized to reduce primary stress and uniform temperatures should be maintained throughout the blanket to reduce thermal stress.

The EVOLVE (Evaporation of Lithium and Vapor Extraction) concept was created to address these specific issues. It uses the vaporization of lithium to remove heat from the fusion system. Trays of liquid lithium are stacked poloidally around the first wall and receive significant energy loads from the plasma. At issue in this study are the localized void fractions produced in the boiling lithium trays. A generalized methodology is proposed for determination of the void profile using an empirically derived formulation based on isothermal experiments at the University of Wisconsin. A standard drift-flux model was used to empirically fit data from liquid metal experiments utilizing nitrogen gas. We apply this model to these boiling lithium trays. We are currently analyzing a system that operates nominally at 1200 C and 0.037 MPa, with a surface heat flux greater than 2 MW per meter squared and a neutron wall loading greater than 10 MW per meter squared. Preliminary analyses have shown void fractions at the top of the pool top ranging from 63% to 65%.

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Topic Preference: **First Choice:** Fusion Blanket and Shield Technology

Second Choice: Fusion Power Reactors

Oral Preference

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