HEAT REMOVAL FROM THE PLASMA FACING MAJESKI-KAITA LIQUID LITHIUM TRAY[1]

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While physically the Majeski-Kaita Liquid Lithium (MKLiLi) tray represents a simple pool filled with the liquid lithium, it possesses unique heat transfer capabilities. Under the localized heat deposition to the surface of MKLiLi, which would be typical, e.g., for the divertor applications, the Marangoni flow is generated by the reduced surface tension $\sigma(T)$ at high temperatures, $\sigma'(T) < 0$. Because of the fluid viscosity the flow (directed along the bottom) penetrates into the bulk of the fluid.

While so far, this effect has been essentially unknown and, thus, neglected in the MHD of liquid lithium, the presented theory shows that the fast heat removal from the heating zone by Marangoni flow is consistent with the recently discovered on (by R. Majeski and R. Kaita, PPPL) extraordinary heat propagation from the high power e-beam spot on the surface of the liquid Li tray on the Current Drive eXperiment-Upgrade (CDX-U) machine.

The theory of Marangoni flow in thin lithium layer MHD is outlined in the talk. Because of the presence of the magnetic field in fusion devices, only thin layers are of practical interest. The effect of flow on heat removal from hot spots (or strike lines) has been assessed with and without magnetic field.

The 3-D numerical code Cbebm was created to simulate the heat transfer from the localized heating zone at the surface of liquid Li. At the moment, it includes a complete 3-D temperature evolution equation, while the 3-D distribution of flow velocity is calculated assuming its stationary viscous distribution. Extension of Cbebm to full viscous dynamics and MHD effects is envisioned in future.

In contrast with conventional thermo-conduction case, when the heat zone remain localized, while the peak temperature is sensitive to the peak power deposition, in MKLiLi the peak temperature is not sensitive to the power deposition profile. Instead, the Marangoni flow expands the heat zone over entire surface area.

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