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# EXPERIMENTAL AND NUMERICAL INVESTIGATION OF THIN FILM DRY-OUT FOR LIQUID-PROTECTED DIVERTORS

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Recent studies performed by the ALPS and APEX programs on liquid-protected plasma-facing components have established guidelines for the maximum allowable liquid surface temperature to limit plasma impurities to an acceptable level. Similar guidelines for the maximum allowable surface temperature gradient are also required to prevent film dry-out due to thermocapillary effects. The expected spatial variations in wall loading and the resulting liquid surface temperature gradients can lead to significant thermocapillary forces that draw the liquid film away from relatively high temperature regions.

A numerical model using the level contour reconstruction method was used to establish generalized charts for the maximum allowable spatial gradients in the incident heat flux (or surface temperature) as a function of the governing non-dimensional parameters. The numerical model tracks the axisymmetric evolution of the liquid free surface above a non-isothermal solid surface for several candidate coolants including lithium, Flibe, lithium-lead, gallium, and tin. Experimental studies of thin circular films of silicon oil on a stainless steel surface were used to validate this numerical model. Radial temperature gradients were imposed on the steel surface using a resistance heater at the center and a cooling channel at the edge of the surface. Radial profiles of the steady-state film thickness were measured using a needle contact technique. The effects of imposed surface temperature gradient and initial film thickness were investigated and compared to numerical simulations for similar material properties and surface temperature gradients on a "non-flowing" thin liquid film. The results of this investigation allow designers of liquid-protected plasma facing components to identify the parameter ranges for successful operation of such protection schemes.