EXPLORING FLOWING LIQUID FREE SURFACE PFC* CONCEPTS: *Dynamics of fast flowing lithium streams under fusion relevant magnetic fields*

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The use of fast flowing lithium streams for protection of the divertor surface in a magnetic fusion device is a very attractive option for effective particle pumping and surface heat removal. The divertor magnetic field environment tends to create strong flow disrupting magnetohydrodynamic (MHD) forces, which pose a major challenge in establishing a smooth and controllable flow. The present study builds up on the ongoing research effort at UCLA, directed towards understanding the unique behavior and characteristics of MHD free surface flows under complex magnetic field environments.

The 3D incompressible MHD free surface code, 'HIMAG', developed by HyPerComp Inc. in collaboration with UCLA has been applied to several problems of interest. This unique code was developed to allow multiple solid and liquid phase materials with arbitrary geometry to be modeled. These simulations have proven pivotal in understanding the basic MHD behavior of fast flowing lithium streams on rectangular electrically conducting substrates. With a view to facilitate design related studies for a flowing lithium based PFC divertor system, numerical simulations have been carried out to access the role of parameters like the width of the electrically conducting flow channel, injection velocity of the liquid metal stream, the direction of flow (inboard towards outboard and vice versa), the presence of an electrically conducting injection nozzle etc. Furthermore, HIMAG capabilities are being enhanced to include simple models for plasma current and momentum flux coupling. A heat transfer analysis with the applied plasma heat flux will also be carried out. The results from these numerical models will be duly presented.

In addition, new experimental studies of wide channel liquid gallium alloy MHD flows at the UCLA MTOR facility with replicated NSTX** divertor region magnetic field conditions are being carried out. Besides providing an understanding of MHD behavior of the flow, these are expected to help gain valuable experience in handling actual flowing liquid metal streams (sans lithium) under typical divertor geometries.