Analysis of thermofluid and MHD pressure drop in liquid metal LiPb duct with flow channel inserts

Hongyan WANG, Chan TANG, Litong HE

School of Energy and Power Engineering, Nanjing Institute of Technology, China

Corresponding author: hywang@ipp.ac.cn

The liquid metal blanket is considered as one of the most promising fusion reactor blankets. Physical and chemical properties of liquid metals (LiPb eutectic) as for instance the low melting and high boiling temperatures, the chemical inertness with water or oxygen, makes LiPb favourable candidates as core coolant of fusion reactor blanket. However due to their high electrical conductivity, liquid metals have strong magnetohydrodynamic (MHD) interaction, which MHD effect remains a key issue. Using flow channel inserts (FCIs) was proposed in the He/LiPb dual-cooled (DLL) blankets [1-2]. The FCIs serve as electrical and thermal insulator allowing for sufficient reduction of the MHD pressure drop and heat loss from the breeder into the cooling helium flows. The reductions in MHD pressure drop are difficult to predict with existing tools, and there are no available experimental data to check the few current predictions.

The paper intends to do some research about LiPb flow in duct with FCI of the fusion reactor blanket. The MHD effects of liquid metal LiPb flow inside FCIs in the ducts with variously heated sides have been considered and numerically simulated. Effectiveness of the FCI as electrical and thermal insulator was assessed by using special MHD code for a fully developed MHD flow and heat transport. The influence of the electrical and thermal parameters of the FCI on MHD pressure drop and heat leakage from the breeder into the helium flows has been studied. The theoretical and experimental formulae have been presented for the pressure drop of the liquid metal LiPb inside FCIs. The comparison has been given between the numerical and experimental results, and the difference between them has been discussed. The results of the experiment and numerical simulation have been validated to evaluate thermal-hydraulics parameters of the liquid metal LiPb flow inside FCI, to develop measurement techniques for heat transfer of the local LiPb flow in blanket ducts.

[1] Y. Wu, FDS Team, Fusion Engineering and Design, 81, 2006, pp:2713-2718.
[2] Y. Wu, W. Wang, S. Liu, et al., Chinese J. Nuclear Sci. and Eng. 25(1), 2005, pp: 76-85.