Experimental investigation of MHD effect due to FCI electric conductivity and structure differences

Zengyu Xu, Chuanjie Pan, Xiujie Zhang, Xuru Duan and Yong Liu
Southwestern Institute of Physics  P.O. Box 432, Chengdu, Sichuan 610041, PRC
E-mail contact of main author: xuzy@swip.ac.cn

Abstract. After the initiation experiment of FCI flow MHD effect investigation was carried out using LMEL-U facility in the Southwestern Institute of Physics (SWIP), China, other experiments are also performed of FCI having a difference in the conductivities and the structures. The experimental results show that FCI result in the complex and drama velocity contribution in the center-plane of the cross section of the duct; and which is out of the numeric simulation and classical MHD theory expectations. But the results can be understood on physics by using the secondary flowing MHD phenomena. The secondary flow caused the complex velocity contribution MHD effect is a great challenge for liquid metal blanket system heat transfer design. The experimental results also show that the all of the four FCI conditions can reduce the MHD pressure drop.

1. Introduction

Liquid metal blanket concepts are still attractive ITER and DEMO blanket candidates. Though some numerical analysis results and primary experimental results of MHD flow in a duct with FCI can be found \cite{1-4}, but it is still far from to understand the physics behind FCI flow MHD characters. How to understand and reduce MHD pressure drop a duct with FCI still remains a key issue. One of the causes, it is that the experimental data is very limitation. To get more widely range experimental data to help us to understand FCI flow MHD effects, the experiments of MHD flow in a 304 stainless steel (SS) duct with 304 FCI with a pressure equilibrium holes (PEHs) and with a pressure equilibrium slot (PES) are performed in Southwestern Institute of Physics (SWIP), China, and an effort is also made of understanding the experimental results on physics.

2. Experiment Description

The experimental investigation of FCI flow MHD effect program is implemented using the Ga-In- Sn liquid-metal loop in Southwestern Institute of Physics (SWIP), China included four FCI Cases: Case I, epoxy FCI with a pressure equilibrium slot (PES); Case II, epoxy FCI with a pressure equilibrium holes (PEHs); Case III, 304 stainless steel (SS) FCI with PES; Case IV: 304 SS FCI with PEHs. The Schematic of the test sections in the uniform magnetic field is shown in FIG.1. The major experimental parameters are in below: The uniform magnetic field space is 740 mm (length) x 170 mm (width) x 80 mm (height), in which the maximum transverse field intensity of $B_0=2$ T was applied. An electromagnetic (EM) meter measured the generally average velocity ($V_0$) and the error was better than 1.2%. The EM pump with a capacity of 5700kg/h drove the liquid metal ($Ga_{68}In_{12}Sn_{20}$) circulation. The sensor of pressure