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Thermal Loads on FTU Actively Cooled Liquid Lithium Limiter

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Power load on the divertor is one of the main problems to be solved for steady state operation on the future reactors and liquid metals (Li, Ga, Sn) could be a viable solution for the target materials. Since 2006 experiments by using a Capillary Porous System (CPS) Liquid Lithium Limiter (LLL) were successfully performed on FTU indicating a good capability of the system to sustain power loads. In order to prevent the overheating of the liquid Li surface and the consequent strong Li evaporation for T > 500 ℃, an advanced version of LLL has been realized and installed on FTU by using the same vertical bottom port of the previous limiter. This new system, named Cooled Lithium Limiter (CLL), has been optimized to demonstrate the lithium limiter capability to sustain thermal loads as high as 10 MW/m^2 with up to 5s of plasma discharge duration. CLL includes an actively cooled system with water circulation at high pressure and is characterized by: 1) the small thickness of the Li CPS meshes (of W) placed in direct contact with the cooling tube (of Mo) and 2) the double role of water circulation at the temperature of about 200 ℃, for heating lithium up to the melting point and for the heat removal during the plasma discharges. The heat load on the CLL is evaluated by different means: a fast infrared camera observing the whole limiter, the temperature measurements of inlet and outlet water as detected by the thermocouples and the measurements of the electron temperature and density by Langmuir probes placed on the CLL. Thermal loads analysis is performed by applying ANSYS code that has been adapted to the real CPS geometry and to the active cooling conditions of the new limiter. As first step, CLL has been tested in the FTU scrape-off layer to identify the best plasma conditions for a good uniformity of the thermal load by using the intensity of the Li and D atom emission at 670.8 nm and 656.3 nm to control Li production. The first experiments analyzed so far and simulated by ANSYS code, point out that heat loads as high as 2-3 MW/m^2 for 1.5s have been withstood without problems. Analysis is in progress for plasma discharges with CLL inserted deeper in the FTU scrape-off layer and close to the LCMS. In this paper the heat load measurements and their analysis will be reported and discussed to provide a clear understanding of CLL behavior under plasma discharges.

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