Contribution ID: **406** Type: **Oral**

Experiments on FTU with a liquid tin limiter

Thursday 25 October 2018 18:10 (10 minutes)

In this paper we report experimental results obtained, for the first time in the world, in a tokamak with a liquid tin limiter (TLL). The FTU TLL was realized by using a molybdenum tube covered with Capillary Porous System (CPS) made by stripes of tungsten felt filled with tin. The TLL can be cooled by flowing air and atomized water inside a copper pipe inserted in the molybdenum tube. To test TLL, a standard FTU discharge was used with a toroidal field B_t = 5.3 T, a plasma current I_p = 0.5 MA and an electron density n_e ≤ 1.0 10^20/m^3. The thermal load on the limiter was progressively varied moving up the limiter shot by shot in the scrape-off-layer (SOL), until almost reaching the last closed magnetic surface (LCMS). The most significant results without active cooling, were obtained by increasing the heat load on the TLL by changing the average electron density from 0.6 to 1.0 10^20/m^3. The thermal load onto the TLL by Langmuir probes increased proportionally with the electron density reaching a value greater than q_LP = 15MW/m^2 for almost 1s for TLL position close to the LCMS. By looking at the temporal evolution of the IR maximum surface temperature and of the measured Sn XXI line emission monitored by the UV spectroscopy, it was deduced that tin evaporation becomes the dominant tin production mechanism when the maximum surface temperature (T_s,max) of the limiter exceeds 1300 ℃ up to the upper value of 1700 ℃ reached at the end of the pulse. A maximum heat flux of q_max=18 MW/m^2 resulted in this case by the application of the 3D finite-element code ANSYS to the real design of the limiter and of CPS. A concentration of tin of about 5.0e-04 of the electron density was deduced from the Z_eff value. By applying the JETTO code, no significant difference was found in the confinement time with respect to the case of absence of tin limiter and without degradation of the plasma performance. No droplets into plasma and no damages were observed on the TLL after the plasma exposition.

Country or International Organization

Italy

Paper Number

FIP/3-5Rb

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Session Classification: FIP/3 DEMO & Advanced Technology

Track Classification: FIP - Fusion Engineering, Integration and Power Plant Design