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High Density Regime in Ohmic TCV Discharges with Positive and Negative Triangularity

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Studies of high density plasmas approaching the Greenwald limit are timely and necessary in view of future reactor operation, both to gain a phenomenological understanding of their behavior and to validate and improve the theoretical treatment of their stability, confinement and control, as well as the physics underlying the density limit process itself. One of the key features of the TCV tokamak is the possibility to change plasma shaping in a wide range of plasma elongation and triangularity. In previous TCV experiments it was shown that in both ohmic and ECRH L-mode discharges the plasma confinement time increases with plasma elongation and decreases with triangularity. In the present work the operational space of TCV has been extended to densities close to the Greenwald limit, and the evolution of the Ohmic confinement with the density increase has been investigated in limited discharges with positive and negative triangularity.
We find that the limit density value has the same increasing dependence on plasma current in both cases; however, the dependence is weaker than predicted by the Greenwald formula. The limit density approached the Greenwald limit only in the delta_95>0 case at low current. In discharges with delta_95<0 the value of the limit density appeared to be lower in the whole density range explored.
The increase in plasma density in both cases was found to be accompanied by a change in sawtooth behavior, namely an increase in the sawtooth period, a modification of the relaxation dynamics, and a reduction in regularity (variable period and amplitude); this was then followed by the disappearance of sawtooth oscillations altogether. Energy and particle confinement are also affected by the density increase. In discharges with delta_95>0 a transition from linear to saturated ohmic confinement is observed at a line-averaged density (4-4.5)*10^19 m^-3, and the start of the sawtooth-free phase is followed by a decrease in the energy confinement time. In the delta_95<0 case the confinement behavior was found to be strongly dependent on plasma current: at high I_p (q_95~3) the density dependence of tau_E is similar to the delta_95>0 case, whereas at low current (q_95~5.5) a pronounced confinement degradation with density is observed. The possible role of MHD activity and the effect of the gas-puffing rate will be discussed.

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