Modelling of Edge Plasma Rotation Accounting for a poloidal Divertor and Helical Perturbation Coils in TEXTOR

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Coil systems for dynamic edge ergodization are implemented at TEXTOR /1/ to control the plasma properties in the edge region the last flux surface of which may be defined by a separatrix of a (planned) poloidal divertor. In particular, the shear of the rotating velocity field determines transport properties in the edge region. Therefore we concentrate in this contribution on the momentum and heat transport evoked by the (rotating) helical perturbations, neutral beam injection, and the neutral gas influx, strongly reduced by the poloidal divertor.

The perturbation coils at TEXTOR are foreseen to have the dominant Fourier components in resonance with the q=3 surface. To control the penetration depth, the winding can be switched as superposition of (m=12, n=4), (m=6, n=2) and a (m=3, n=1) helical coils. Fourieranalysis and field line tracing by means of the Gourdon - code were used to analyse the vacuum configurations. The coils are located at the high field side and the poloidal extension is around 70^o. The axisymmetric coils of the divertor are located in the toroidal surface defined helical coils. Poloidally they are positioned somewhat above and below these coils.

The slip between the plasma rotation and the rotation of the perturbing field determines the build up of the eddy currents at the singular surface and thus the penetration of the Fourier modes and the momentum transfer to this surface /2/. Therefore the toroidal and poloidal momentum momentum balances are set up allowing to compute the respective rotation velocities. By braking or accelerating velocity gradients larger than the growth rates of e.g. the ITG - instability may be generated thus controlling the confinement. Therefore the power balance is set up to estimate the plasma temperature (averaged over electrons and ions). Because of the Fourier components with high poloidal mode numbers, preventing the build up steep pressure gradients at the separatrix due to ergodization, ELM free discharges are assumed.

The main results can be summarized as follows:

Although it is possible to create a large velocity shear around the singular surface by plasma braking, this shear is nonetheless limited by the reduction of the central velocity. With C0 - NBI (720 kW) and a corotating DED (frequency of 10 kHz) a velocity gradient of $\frac{dv_t}{dr} = 1.3\ 10^6 \frac{1}{sec}$ may be generated which should be sufficient to suppress the ITG - instability. A reduction of the transport in the vicinity of the separatrix to an almost neoclassical level can lead to strong increase of the temperature ($\approx 75\%$) at the plasma center.

Since in the case of a rotating plasma the slip frequency at the q=3 surface, $\omega(q=3)$, must be small for 'reconnection', the slip frequency at the q=2 surface $[|\omega(q=2)| \approx \frac{v_t(q=2)}{R_0}]$ is rather large therefore preventing penetration at the q=2 - surface.

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/ 2/ R. Fitzpatrick, Nucl. Fusion 33, 1049 (1993)