Self-consistent pressure and current profiles in high-beta D-^{3}He Tokamak reactors

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D-^{3}He fusion reactor is an advanced fuel fusion reactor which doesn't emit a lot of neutrons from main reaction. But fusion reaction rate of D-^{3}He is smaller than that of D-T. Therefore, it needs high-beta value and high temperature operation.

To maximize the critical beta value against MHD instabilities and bootstrap current fraction, the plasma shape, plasma pressure profile and plasma current profile should be optimized. We used Apollo code (2-dimentional equilibrium code) to investigate equilibrium of arbitrary shaped core plasmas of tokamak reactor [1].

We calculated critical toroidal beta values versus plasma shape parameter (aspect ratio A, triangularity δ) , obtained results that critical toroidal beta increases rapidly in case of $0.3<\delta<0.5$ at the point of A=1.5, and gained plasma configuration with negative magnetic shear (low safety factor value in the center) that critical toroidal beta value is ~10% and bootstrap fraction is ~75%(A=3.0, δ=0.3, κ=1.7 ITER-like design) as shown in Fig.1. In the lower aspect ratio case, optimized safety factor profile will be clarified in the near future.

Besides, in high temperature operation, synchrotron radiation becomes dominant, and non-local analysis of this radiation is important to get accurate temperature profile.

We employed Cytran routine coupled Total-T code (1.5D equilibrium and transport code) and calculated non-local Synchrotron radiation effects for several wall reflection coefficients [2]. When the wall reflection of Synchrotron radiation is higher than 0.95, central radiation loss decreases and the edge absorption becomes important as shown in Fig.2. So that, the wall reflection higher than 0.95 is important to accomplish high temperature D-^{3}He plasmas.

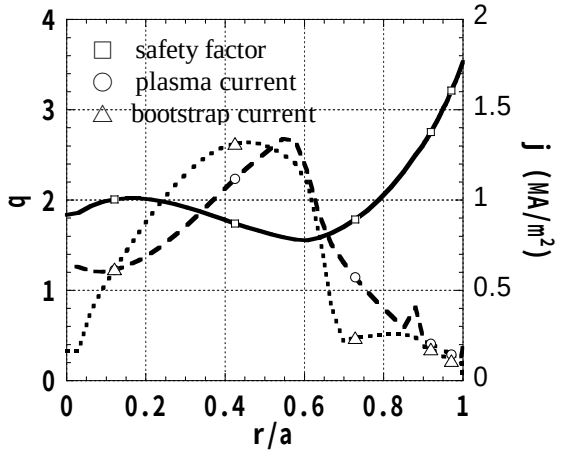

Fig.1 Plasma current and bootstrap current profile at negative magnetic shear profile.

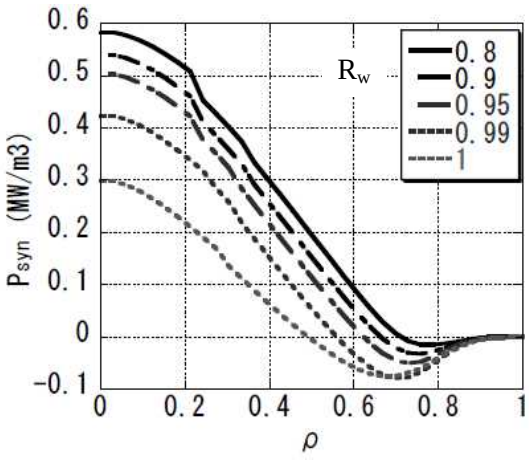

Fig.2 Synchrotron radiation power profile for several wall reflection coefficients R_w.

[1] K. Yamazaki, et al., Nucl. Fusion **25** (1985) 1543.

[2] F. Albajar, M. Bornatici, F. Engelmann, Nucl. Fusion **42** (2002) 670.