Search for quasi-isodynamic configurations with diminished Pfirsch-Schlüter current

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Quasi-isodynamic [1] (*qi*) configurations have been previously found by numerical optimization with high stability β limit, good neoclassical confinement properties and excellent fast particle collisionless confinement [2,3]. It was shown analytically [3] that the secondary (Pfirsch-Schlüter) current in quasi-isodynamic configurations remains contained within a plasma field period, namely, between the cross-sections with maximal magnetic field strength B. In the *qi* configurations considered earlier, the divergence of the electric current perpendicular to the magnetic field lines changes sign only once along the magnetic field within one system period. From this it follows that, for example, in the outward part of the plasma column, the secondary current cannot change sign. Thus, the toroidal effect cannot be eliminated. The dipole secondary current is one of the causes of local mode instability. The search for possible ways to diminish this current in quasi-isodynamic configurations constitutes the main goal of this work.

The simplest approach corresponds to a configuration with large enough number of periods that is optimized toward quasi-isodynamicity. In this case, the dipole secondary current is intrinsically small so that a large $<\beta>$-limit can be achieved. The main effort, however, is directed toward the search of the more interesting case of moderate number of period and aspect ratio. As an initial step, a simple model is used to analyze the possibility to satisfy simultaneously the quasi-isodynamic condition and the condition of zero dipole secondary current. In this model, the Fourier spectrum of B in magnetic coordinates is considered as variable and its choice is used to satisfy the conditions considered. It is shown that from this view-point, the *qi* and zero secondary current conditions are not incompatible. In the next step, computational optimization is applied to find the boundary magnetic surface of the configuration with complex periodic structure that approximately satisfies the *qi* and small Pfirsch-Schlüter current targets. The properties of the configuration found will be presented.

References

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