§6. Controlling the Cross-field-flux of Cold $\alpha$-Particles with Resonant Magnetic Perturbations in a Helical Fusion Plasma Device

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A new scenario to control transport of “cold” $\alpha$-particle flux in the Force Free Helical Reactor [1] by changing poloidal field (PF) coil current during plasma discharge is proposed here. A way to enhance the radial transport of the $\alpha$-particles in the intermediate energy range is considered which relies on specific features of helical magnetic field. These are the $\beta$-induced change in the $B/B_0$ modulation along the particle trajectory to remove helically trapped cold $\alpha$-particles [2] and the resonant effects to remove passing $\alpha$-particles [3].

For the helically trapped and passing non-resonant $\alpha$-particles separated with the velocity phase space parameter $V_{\perp}/(V_{\perp}^c e_{\text{off}}^{1/2})$ confinement time ratio $\tau_\alpha/\tau_E$ connected with the transport coefficients $D_{1/v}$ and $D_{\text{plateau}}$ is the following

configuration $R$ and minor radius of the magnetic surface $r_0$ as follows

$$\omega_i + m_i \left( \frac{V_{\perp}}{R} (r_e^{c}) - \frac{V_{\perp}}{r_0} \right) = 0$$

This resonance condition shows that the perturbations with the nearest to 10/10 numbers, namely 11/10 and 12/10, also can make their contribution to the drift resonances (Fig.2)

Fig.2. Resonance condition for the passing cold $\alpha$-particles

The perturbations mentioned above can be caused with the “correcting coils” which complement the main vertical field coils (Fig.3).

Fig.3. Layout of coils. Fig.4. Fluxes of cold $\alpha$-particles

Perturbations by correcting coils makes possible to control the cold $\alpha$-particle fluxes $\Gamma_{\text{plateau}}$ and $\Gamma_{\text{perturbation}}$ (Fig.4), i.e. either to enlarge or to decrease the loading on the divertor plates.