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TH/P2-15: Impact of Fusion Alpha Driven Current on the Magnetic Configuration of a Tokamak

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The paper evaluates the influence of fusion alphas on burning plasmas in future tokamak reactors. In comparison to the relatively weak effect of charged fusion products (CFPs) in today's devices, the substantially enhanced fusion power in burning tokamak plasmas may bring on a significant impact of CFPs on the equilibrium and bulk plasma parameters. Based on 3D Fokker-Planck modelling of DT fusion alphas we analyze here their effect on the plasma current and equilibrium in basic ITER scenarios. Particularly considering the peculiarities of the velocity and spatial distributions of confined alpha particles with energies exceeding a hundreds of keV, we calculate the poloidal profiles of the total alpha induced bootstrap current as well as of the fusion power deposition to bulk plasma electrons and ions. The present study demonstrates that fusion alphas are expected to induce an additional rotational transform of the magnetic field lines in reactor size tokamak plasmas. In reversed shear plasma scenarios the impact of the alpha driven current appears to be greater. While in the ITER steady state scenario alpha particles induce a 15% reduction of the safety factor in the core area, in the 2nd ITER Scenario with positive shear the safety factor reduction in the core is < 5% according to our calculations. Nevertheless, also such an alteration may reduce the core safety factor, which in Scenario 2 is only 1.02-1.04, to a value below 1, the crucial value for plasma stability. It is noted that, in spite of the low intensity of the total current driven by fusion alphas, the alpha driven current can play a role of a seed current for the bootstrap tokamak reactor. Evidently, the development of advanced plasma scenarios and research programs for ITER and future tokamak reactors should account for the effects of currents driven by fusion alphas.

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Collaboration (if applicable, e.g., International Tokamak Physics Activities)

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