Possible parameters of fusion systems based on field reversed magnetic configuration

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Field Reversed Configuration (FRC) is the magnetic trap with a high ratio β of plasma pressure to the magnetic pressure (β ~ 1). FRC combines the properties of closed and open magnetic traps. High β potentially provide to achieve high power in a relatively compact system. For D–3He fueled fusion systems, high β is required for energy efficiency [1]. The main advantage of D–3He reaction as compared to D–T reaction is the ability to operate with neutron yield of about 5 %, which is significantly lower than 80 % in the D–T reactor.

From a technical point of view, the possible parameters FRC of reactors [2 , 3] seem acceptable. From the point of view of the FRC fusion prospects, the greatest problem is the evaluation of turbulent transport. The proposed scaling laws for the confinement time [4] are a good description of transport in the experiments. But their extrapolation to the reactor regimes is not entirely justified. To justify the reasons for the turbulent transport, the theory of electromagnetic gradient drift instabilities is proposed [5, 6]. The estimated parameters of the drift instabilities correspond to the existing measurement data. For comparison with the experiments and prediction of the fusion regime confinement time, we use the transport model [7], taking into account the transversal particle losses from closed field lines region and the losses along the open field lines. The estimation of transverse diffusion coefficient and the relationship for the global confinement time are suggested. Also we analyze the following processes that affect the energy balance: radiation, kinetics of fast particles, effect of impurities.

The estimates of fusion systems with D–T and D–3He fuel are presented. In a system with parameters close to the parameters of the today’s devices, power gain factor *Q* ~ 0.1 for D–T fuel. Such a system can be considered as a source of thermonuclear neutrons. In the fusion regimes with *Q* ~ 10, heat and neutron fluxes on the first wall become unacceptably high. In the case of low-radioactivity D–3He reactor, neutron flux < 0.3 MW/m2, heat flux ~ 3 MW/m2. Fore the regimes with *Q* > 10 at a plasma radius of 2–2.5 m, formation of improved confinement regime is required (for example, generation of shear flows).

In our opinion, presented results allow to justify the prospects of fusion systems based on FRC.

References

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