Energy yield of thermonuclear fuel

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Use of the D^3He-fuel as the efficient fuel in thermonuclear process is considered. It is shown that this type is preferable due to some aspects rather than traditional DT-plasma [1]. The ignition temperature value for the D^3He fuel is greater that for traditional DD or DT fuels. The extreme conditions should be kept for reaching the ignition and achieving self-supporting thermonuclear process stage. We assume, for such conditions, temperature value about ~40-50 keV and total densities of D^3He fuel as ~10^{23} cm^{-3}. Realization of the process is possible only by bringing fuel to mentioned conditions for a very short time as ~10^{-8}-10^{-7} s.

The energy yield of the burning of the fuel implies the detection and use of product particles (charged, neutral) that leave the local burning area. However those high-energy product particles while passing the burning volume transfer heat to the fuel mainly by Coulomb scattering. The deposited in such way energy rise the temperature of fuel. This affects the reaction rate as it increases with temperature, and, therefore, the production of high-energetic particles also increases. The temperature equalization occurs in ~10^{-12}-10^{-11} s. after the energy transfer. Because of fact, that this value is relatively small in comparison with whole thermonuclear process time, the bulk fuel particles are always considered to be described by Maxwell distribution.

1. The high energetic reaction products, mainly 14,68-MeV protons, 14,07-MeV neutrons and 3,67-MeV α-particles determine the energy deposition and yield of the thermonuclear process. For these energetic particles the average relative energy transfer $\langle\frac{\Delta E}{E}\rangle$ calculated over the range of impact parameters. This directly implies the averaging over the all scattered angles of projectiles. The $\langle\frac{\Delta E}{E}\rangle$ value depends on the mass ratio of interacting particles.

The average distance between fuel particles with considered fuel conditions allows mentioning only quasi-elastic scattering in distant flight approach $n^{-\frac{1}{3}} \gg b$. Where b-impact parameter of projectile, n-fuel particle concentration.

Here we estimate average energy deposition of high-energetic particle in quasi-elastic scattering, and the energy yield of the fuel. The burning process is simulated over the time. The results are compared with those for traditional DT, DD fuels.

2. The diagnostics of the energetic particles emphasizes determination of the particle population outgoing of burning volume, energy of particles, temperature of burning volume. By using the wall elements with amounts of ^6Li, ^9Be, ^{12}C due to reactions $^6Li(t,p\gamma)^8Li$, $^6Li(d,p\gamma)^7Li$ $^9Be(\alpha,n\gamma)^{12}C$, $^{12}C(d,p\gamma)^{13}C$ the diagnostics of protons, alpha-particles and deuterons is possible [2,3]. Also the D^3He fuel can be used as thermal neutron → fast neutron converter [4].

References

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