§20. Nuclear Processes in D-^{3}He Fusion Reactor Plasmas

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In self-sustaining D-^{3}He Plasmas, the following fusion reactions take place: ^{3}He(*d,p*)α, D(*d,p*)T, D(*d,n*)^{3}He and T(*d,n*)α. Besides these thermonuclear processes, nonthermal reactions such as the breakup of deuteron, D(*p,pn*)p, would occur to a certain extent.

The breakup reaction can occur because the binding energy of deuteron is only 2.2MeV. It would be induced by D-^{3}He fusion protons while they slow in the plasma down to 3.3MeV, the threshold energy. (See the cross-section curve in **Fig.1**.) Since the reaction is of endothermic nature, the occurrence of it implies the decrease in the amount of the magnetically-trapped 14.7-MeV proton's energy to be deposited to the plasma.

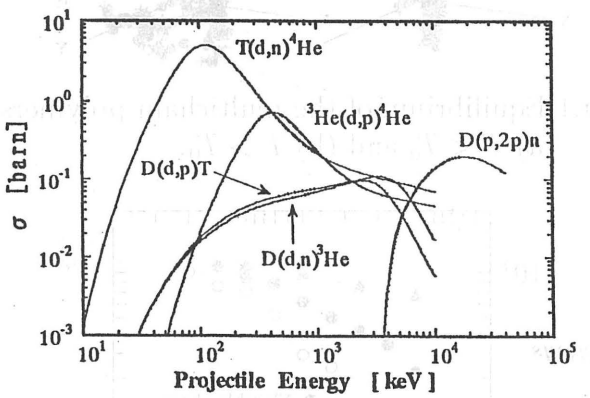

Fig.1 Cross-sections as a function of projectile energy

In this study we examined the influence of the deuteron breakup reaction in self-sustaining D-^{3}He plasmas, on the basis of coupled slowing-down / power-balance calculations. We supposed plasma conditions close to a conceptual D-^{3}He/FRC reactor design[1]. The results are summarized as follows.

The breakup probability, *i.e.* the number of breakup reactions per 14.7-MeV proton trapped in the magnetic field was estimated to be 6-10% at typical D-^{3}He plasma condition (T = 80-100 keV).

Figure 2 shows the confinement parameter $n_e \tau_E$ at 80-keV plasma temperature as a function of ξ, the fraction of 14.7-MeV protons directly lost out of the plasma. When $\xi \approx 0$, the breakup reaction has no influence on the confinement requirement; however, with increasing ξ, the ignition becomes severer. This is because with inreasing ξ, the proton density ratio n_p/n_D increases and so the ratio of the energy dissipation due to D(*p,pn*)p to the total energy loss out of the plasma. When ξ=38%, which is the value estimated in Ref.[1], the increament of $n_e \tau_E$ due to the breakup reaction is 16%.

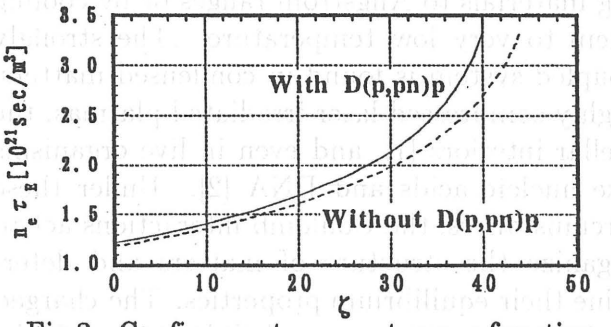

Fig.2 Confinement parameter as a function of direct loss fraction (T=80keV)

Reference
[1] Momota,H., *et al.*, *Fusion Technol.* **21**(1991)2307.