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Concept Design of GDT-Based Fusion Neutron Source for Improving the Q with High Field Neutral Beam Injection

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Gas Dynamic Trap (GDT) is very attractive as a kind of fusion neutron source for testing fusion material and component as well as driving transmutation reactor due to its linear and compact structure, easiness of construction and maintenance, relatively low cost and tritium consumption. These years, the conceptual designs of GDT-based neutron source for above two purposes, named FDS-GDT, have been proposed as candidate of fusion neutron source by Institute of Nuclear Energy Safety Technology (CAST) • FDS Team in China, which focus on fusion safety and fusion nuclear science and technology research. However, the fusion energy gains (Q) in current international designs are still far lower than one, even about 0.05.

In order to improve the Q and reduce the technologies requirement of magnet and neutral beam injection (NBI) for GDT-based fusion neutron source, a new method was proposed with high field neutral beam injection (HFNBI) for substituting the conventional method that the neutral beams are obliquely injected at middle plane of GDT where the field is minimal. This method will benefit for confining higher density of fast ions at turning point in the zone with higher magnetic field, as well as getting higher mirror ratio by reducing mid-plane field rather than increasing the mirror field. In this situation, the collision scattering loss of fast ions with higher density will be critical and change its confinement performance, power balance and particles balance.

Two optimal designs of GDT-based fusion neutron source was proposed with HFNBI by using updated calculation model and based on SYSCODE. One is for improving Q to 0.5, about 10 folds comparing to conventional design scheme, and the fusion power is 18MW. The other is for reducing the NBI power and mirror field to enabling level, such as 10MW and 10T respectively, and the fusion power is 2MW and Q is 0.2.

Eligible for student paper award?

No

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