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ICC/P3-01: Stability and Confinement Improvement of Oblate Field-Reversed Configuration by Neutral Beam Injection

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The first experimental investigation of tangential neutral beam injection (NBI) application on oblate field-reversed configurations (FRCs) has been conducted in the TS-4 plasma merging device. The low-n modes are responsible for the short discharge duration of the oblate FRCs formed from light gases. The co-NBI with injection power of 0.6 MW largely extended the magnetic energy decay time of oblate FRCs, while no improvement was observed in the counter-NBI case in which the fast ions are not confined inside the separatrix. These results indicate that the NB fast ions stabilized the low-n global modes and prolonged the discharge duration. Oblate FRCs produced from heavier gases such as argon and xenon show better stability against the low-n modes due to kinetic or two-fluid effects. The argon FRC without NBI shows a degraded confinement state with flux decay time of ˜ 0.03 ms. The NBI significantly extended the flux decay time to ˜ 0.2 ms while the injection power is much smaller than the maximal loss power of 11 MW. The reduced total loss power of less than 5 MW indicates that NBI not only heats FRC plasma but also changes the equilibrium and transport properties. The observed thermal pressure outside of the magnetic axis in the case with NBI shows significant increment from the case without NBI, as expected from the orbit calculation of NB fast ions. The expected NB power deposition density of 8.5 MW/mˆ3 will be large enough to modify the pressure profile locally since the volume averaged loss power density of the FRC was 10 MW/mˆ3. The current density profile outside of the magnetic axis was also changed to satisfy pressure balance, suggesting that the diamagnetic plasma current is spontaneously driven by the modified pressure profile in the NB-injected FRC. Though these modifications were localized outside the magnetic axis, the flux decay was suppressed in a wide area of the FRC. These results indicate that the utilization of NBI might bring about improvement of FRC confinement by active control of pressure and current profiles as well as electron heating. This work was partially supported by a Grant-in-Aid for JSPS Fellows 23-2462 and the Core-to-Core Program No. 22001.

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