IAEA FEC 2014

Contribution ID: **72** Type: **Poster**

Plasma Current Start-up without Central Solenoid in the Iron Core STOR-M Tokamak

Thursday, 16 October 2014 08:30 (4 hours)

Plasma current start-up in the iron core STOR-M tokamak (R=0.46 m, a=0.12 m and Bt=0.6 T) without the central solenoid (CS-less) has been demonstrated. The plasma current can be maintained during the iron core saturation phase. In particular, effects of the turn number of the outer OH coils (N=4 or N=6) on the CS-less discharges have been compared. The plasma current start-up is reproducible due to a wide null field region in the absence of bias OH coil current for both cases.
For the N=4 case, the plasma current is ˜10 kA, and the plasma current can be sustained after the additional 3rd capacitor bank is applied near the iron core saturation phase. Slow transition from the unsaturated to partially saturated phase has been observed in the iron core tokamak.
For the N=6 case, the plasma current is increased up to 18 kA for the same fast bank voltage. It has also been noticed that the main discharge is shortened from 35 ms to 20 ms. After the 3rd bank is applied at 18 ms when the magnetizing current was 0.5 kA, the plasma current quickly reached a constant value and then terminated shortly. Although more optimization is needed to prolong the plasma current driven by the 3rd bank, the magnetizing current is smaller due to stronger coupling between OH coils and the iron core. Therefore, the transition time from the unsaturated to saturated phase is shorter, adding slightly more difficulties to the plasma control and optimization.
The experimental results suggest a feasible operation scenario in a future ST. A reliable plasma current start-up can initiated by the outer OH coils with an iron core and the current can be further ramped up to a steady state value by additional heating power and vertical field coils after iron core saturation. A smaller turn number may be beneficial to achieve smoother transition from the unsaturated to saturated iron core phase.

Paper Number

EX/P5-46

Country or International Organisation

Canada

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Session Classification: Poster 5