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Low Loop Voltage Start-up Using Trapped Particle Configuration in Versatile Experiment Spherical Torus (VEST)

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The effect of the poloidal field structure on pre-ionization and start-up has been investigated with a special focus on the trapped particle configuration in VEST (Versatile Experiment Spherical Torus), a spherical torus recently built at Seoul National University. VEST is characterized by two partial solenoid coils installed at both vertical ends of a center stack, which is intended to be used for the double null merging start-up experiment. The pre-ionization using electron cyclotron heating (ECH) has been adopted for the reliable start-up in many tokamaks including spherical torus devices. ECH has been also utilized for the initial plasma start-up experiment of VEST and the radial profiles of plasma parameters are measured using triple Langmuir probe to investigate the effect of poloidal field structure on pre-ionization and start-up. It was found that the electron density increases larger than twofold with small amount of pressure driven current generated when trapped particle configuration is applied. It is also found that the higher plasma current can be achieved under trapped particle configuration with identical loop voltage compared with the case without trapped particle configuration. Up to 40 kA of plasma current could be generated under the trapped particle configuration with sufficiently lower volt-second than that required for the similar current level in field null configuration, which indicates that this kind of structure can be utilized for the saving of volt-second consumption. Experiment results under various magnetic field configurations with varying mirror ratio show that the poloidal field structure with high mirror ratio can result in more efficient plasma start-up with lower loop voltage or ECH power. This result can be utilized for optimal start-up scenario development of tokamaks requiring low loop voltage such as ITER or of spherical torus with limited volts-seconds.

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