Confinement Characteristics of Reheat Mode Discharge in High-Density Regime of Compact Helical System (CHS)

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It is important to explore a good confinement regime in a high density operation because the fusion reactivity is a function of the density squared. In this paper, we report the improvement of global confinement observed in neutral beam (NB)-heated high density plasmas of the low aspect ratio helical system CHS. As suggested by the international stellarator scaling law, the stored energy of NB-heated CHS plasma fueled by the gas puffing shows a tendency to saturate as the electron density n_e increases. Subsequently, the stored energy begins to drop with the remarkable increase of radiation loss when n_e reaches $(8\sim9)\times10^{19}\mathrm{m}^{-3}$. A way to overcome this situation is to reduce the fueling rate by the gas puffing suddenly. The significant recovery and increment of plasma stored energy have been observed in the high n_e regime ($n_e\sim1\times10^{20}$ m^{-3}) of CHS after the gas puff fueling is turned off. This is called the 'reheat mode'. A similar phenomenon has been also observed by control of gas puffing in ohmically heated tokamak plasmas, e.g. ASDEX and JIPP T-IIU. The characteristic differences between the gas puffing and the reheat phases are in the n_e profile and electron temperature T_e at the plasma edge. A Thomson scattering diagnostic shows excessively hollowed n_e profile in the gas puffing phase while n_e is peaked in the reheat phase. A Langmuir probe placed near the last closed flux surface (LCFS) showed a large increase of T_e compared with the gas puffing phase. In addition, a fluctuation level of ion saturation current was clearly reduced in the reheat phase. An interesting observation is that the increment rate of stored energies in the outward shifted divertor configuration is higher that that in the inward shifted limiter configuration. This is supposed to be attributed to the difference in T_e behavior near the LCFS before and after the reheat mode between the two configurations.