Enhanced H-mode energy confinement with positive toroidal rotation in JT-60U

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The edge pedestal structure characterized by the formation of the H-mode transport barrier is known to determine the boundary condition of the heat transport in the plasma core as well as the characteristics of the edge-localized-modes (ELMs). The effect of toroidal rotation on the physical processes determining the pedestal structure and core heat transport is one of the key issues in recent tokamak research.

In this study, conducting the power scans based on three toroidal momentum sources generating the co, balanced and counter-rotation, the characteristics of the heat transport at the plasma core in the variation of toroidal rotation profiles have been investigated in JT-60U. In H-mode plasmas where the ion channel is heated dominantly through the accelerating energy with positive ion-based NBs, the heat transport at the plasma core is conventionally affected strongly by the existence of a critical scale length of the ion temperature gradient, above which significant increase of heat conduction imposes the stiff profile of ion temperature. Ion temperature gradients (ITGs) are believed to be the main origin of turbulence, causing anomalous transport through the ion channel. In JT-60U, it has been observed that the energy confinement is improved when the toroidal rotation is positive using the co-tangential NB. In this case, the plasma pressure at the shoulder of the H-mode pedestal is raised together with the reduction of ELM frequency [1]. While the central ion temperature is increased accompanied by the increase of the pedestal temperature, the saturated ITG scale length is not remarkably changed with the variation of the toroidal rotation profiles. In other words, the improved energy confinement at the enhanced positive toroidal rotation is obtained with the main contribution from the improvement of the edge stability. In fact, the edge pressure is raised with increasing β_{pol} value under the type-I ELMy H-mode phase. The influence of the enhanced positive toroidal rotation profile on the edge stability with the increased field line curvature at the lower field side due to enhanced β_{pol} value will also be evaluated quantitatively.

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