Experimental investigation of halo currents during vertical displacement events in the KSTAR tokamak

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The characteristics of poloidal halo currents (HCs), which flow through the supporting structures for the lower divertors between plasma and the wall of the vacuum vessel during downward vertical displacement events (VDEs) eventually causing plasma disruptions, are experimentally investigated in the KSTAR tokamak. The poloidal HCs are measured with small Rogowski coils (RCs) called as halo current monitors (HCMs) mounted on the supporting structure for the disrupted plasmas due to the downward VDEs under experimental conditions such as plasma current I_p of 0.4 -1.0 MA and toroidal field B_T of 1.5 – 2.7 T, and its magnitude I_h is estimated as 5 ~ 30 % of I_p in the operational range of I_p and B_T. Firstly, the value of I_h is inversely proportional to the current quench (CQ) rate which is evaluated from the linear fit on the wave-form of a plasma current in the phase of the CQ. Plasma current evaluated by using the sum of local poloidal fields measured at plasma facing components (PFCs) is used for evaluating the CQ time because the plasma current previously measured with the RCs on the wall includes the toroidal eddy current on the PFCs during the disruption. Secondly, the value of I_h can be reduced down to 50 % by increasing the amount of the impurity puff (such as N_2) at the lower divertor region which affects the electric resistance in the halo region. Thirdly, the toroidal asymmetric distributions of the HC including the rotating HCs correlating with the occurrence of the $n = 1$ MHD mode are observed, and the distribution can be changed by the resonance magnetic perturbation (RMP) field ($n = 1$) for producing the 3D magnetic field in the plasma edge region. Finally, the HC is also measured with the Langmuir probes (LPs) in the lower divertor region and its magnitude is confirmed by comparing with the HCM measurement, and the halo width can be estimated from the LP measurement.

In this work, the results from the experimental investigations on the HCs, which are needed for the study of the electromagnetic force on the PFCs due to the HC as one of the critical issues on the machine safety for higher operational conditions such as I_p (> 1.0 MA) and B_T (> 3.0T) in the KSTAR, will be presented.