Progress of Impurity-Related Physics Experiment in LHD

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In recent fusion devices dominant impurity ions are only represented by carbon because of the vacuum wall fully covered with carbon plates in addition to the improvement of wall conditioning techniques. Therefore, the impurities do not influence the global power balance except for the edge boundary region, although a few issues are remained on fuel dilution in fusion output and bremsstrahlung or synchrotron radiation in high-density operation. On the other hand, spectral line emissions from the impurity ions are usually used for the particle transport, since the hydrogenic ions have basically no line emission. The production of high-performance plasmas is possible based on an intrinsic nature appeared in the impurity transport and collisionality, in particular, large inward convection. In this session recent progress on physics experiment in Large Helical Device (LHD) utilized the impurity characteristics passively and actively ('impurity-related physics experiment') is presented.

A variety of density profiles have been observed in LHD suggesting a very interesting core particle transport. The impurity transport in the edge ergodic layer formed by stochastic magnetic fields with long connection length (10-2000m) can also exhibit many interesting phenomena, in particular, related to the necessity of edge perturbation field for the ELM suppression in tokamak. Meanwhile, the LHD discharge is quite stable against the impurity buildup, basically up to the global power balance limit, because of the nonexistence of current instability. The specific contents presented along those directions are as follows;

(1) Core impurity behavior with perpendicular transport
(2) Edge impurity behavior with parallel transport
(3) High Z discharges with high ion temperature
(4) Impurity pellet injection with improvement of plasma performance
(5) Impurity pellet ablation under the presence of high-heat flux due to fast ions
(6) Observation of magnetic forbidden dipole transitions with ITER application
(7) Others including future direction

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