

§12. Steady State Operation Test of ICRF Antenna in LHD

Mutoh, T., Kumazawa, R., Seki, T., Shimpo, F., Watari, T.

ICRF heating system for steady state operation of LHD was being developed. The operation test of R&D ICRF antenna and transmission line was carried out at 30kW and 30minutes without any additional antenna load. The RF current and voltage on the transmission line was at the same condition with the plasma heating experiment of 500kW.

The ICRF test set which consists of transmitters, transmission lines, impedance matching stubs, a vacuum feedthrough, a vacuum chamber and a test antenna had been constructed and used for this development test. To remove the resistive heat load generated by RF current, all components are cooled with water which circulate insides of them. The structure of water inlet/outlet of the coaxial transmission line were newly designed and tested. These cooling water channels are connected to the antenna straps, Faraday shield pipes and return conductors.

Steady state operation test was carried out at the frequency of 50MHz and the RF power of 30kW. Operation duration was 30 minutes. The peak standing wave voltage on the transmission line was about 20kV(0-peak). This power level is equivalent to 500kW heating experiment with 5ohm of expected plasma loading resistance.

The surface temperatures of the test antenna were measured with the IR camera trough the BaF vacuum window. The time evolution of the temperatures are plotted in Fig.1. The reason of rapid temperature increase of carbon protectors is RF induction heating of carbon material. The IR radiation signals from the corners of the Faraday shield pipes may be contaminated by the ray emitted from the carbon protectors and reflected by the corners of the Faraday shield.

Except for the carbon plates, temperatures are saturated within 10 minutes and its increments are less than 50 degree.

On the transmission line, outer conductor is not cooled artificially. The temperature increments after 30 minutes operation are shown in Fig.2.

The calculated standing wave voltage is also plotted in a same frame. The maximum temperature increment was observed at the minimum voltage point and it coincides to the maximum current point on the non-matched transmission line.

From these experiments, newly designed cooling system of the transmission line and antenna system seems to be working suitably for steady state operation.

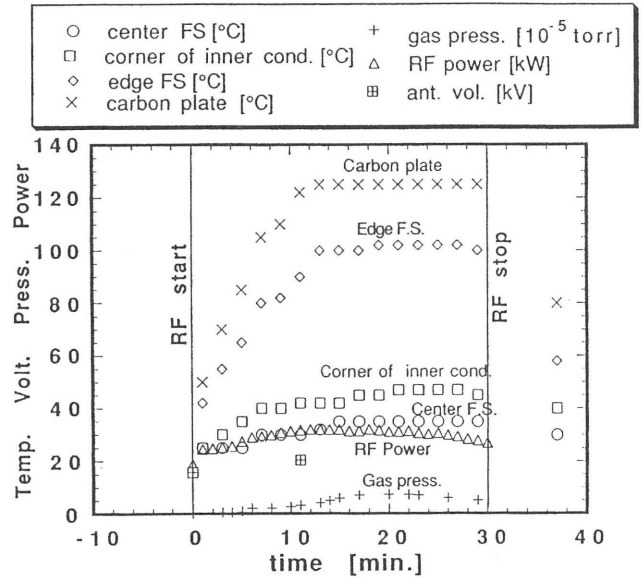


Fig. 1 Time evolution of temperatures of the test ICRF antenna in a 30 minutes operation.

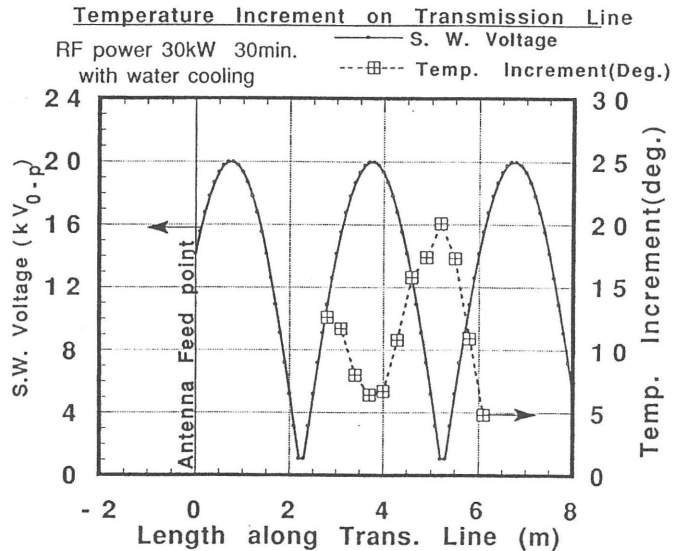


Fig. 2 Temperature increments of the outer conductor on the transmission line during the 30 minutes test run. Calculated standing wave voltage is also plotted. Temperature increment is maximum at the RF current peak position.