§15. Installation of a Liquid Impedance Matching System for ICRF Heating

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A liquid stub tuner has been developed as an improvement of the conventional stub tuner with movable sliding contact. It utilizes the difference of RF wavelengths between in insulating gas and in liquid. It has demonstrated highly reliable performance as a stub tuner [1,2]; it has withstood 63kV for 10 seconds and 50kV for 30 minutes. Furthermore the liquid surface level can be shifted under a high RF voltage without RF breakdown, which suggests that it can be employed as a feedback control impedance matching tool to keep the reflected RF power level at a low fraction against a temporal variation of the plasma loading resistance.

A liquid impedance matching system has been designed and fabricated for ICRF heating system on LHD [2]. The ICRF heating will be applied to the LHD plasma via various heating methods and at various magnetic field strengths. A main purpose of the liquid impedance matching system is that the impedance matching can be obtained at a wide frequency range, 25-95 MHz. This system consists of a liquid stub tuner and a liquid phase shifter. The liquid phase shifter was constructed by connecting two liquid stub tuners in a U-shaped configuration. An impedance matching can be acquired in a wide frequency range, i.e., 25-95 MHz by selecting the length of 4 m for the liquid stub tuner. At some frequencies, it was a problem that the RF voltage at the phase shifter became higher than that between the antenna and the impedance matching system. However, this difficulty has been resolved by adopting the use of asymmetrical heights of liquid surface levels at the U-shaped liquid phase shifter.

Two liquid impedance matching systems were set up at the LHD experimental hall. A pair of ICRF heating loop antennas has been installed from a lower and an upper ports of the LHD vacuum container. Each RF transmission line has connected the liquid impedance matching system and the exit of the ICRF heating antenna as shown in Fig.1. To remove a dissipated RF power the purified water can flow inside the inner transmission line. The ceramic aluminum feedthrough (Al_2O_3) of a cone-type is used to seal a coaxial transmission line at the vacuum. This ceramic feedthrough has achieved the applied RF voltage of 40kV for 30 minutes and 50kV for 10 seconds [3].

On the other hand, RF transmission line has connected the liquid impedance matching system and an RF generator. The RF generator is located at the Heating Power Equipment room, which is next to the LHD experimental hall. The long RF transmission line (about 60m) is laid at the underground passage.

References

1) Kumazawa, R. et al.: Rev. of Sci. Instr. **70** (1999).
2) Kumazawa, R. et al.: 13th Top. Conf. on Applications of Radio Frequency Power to Plasmas (1999).
3) Mutoh, T. et al.: Fusion Technology **35** (1999) 297.

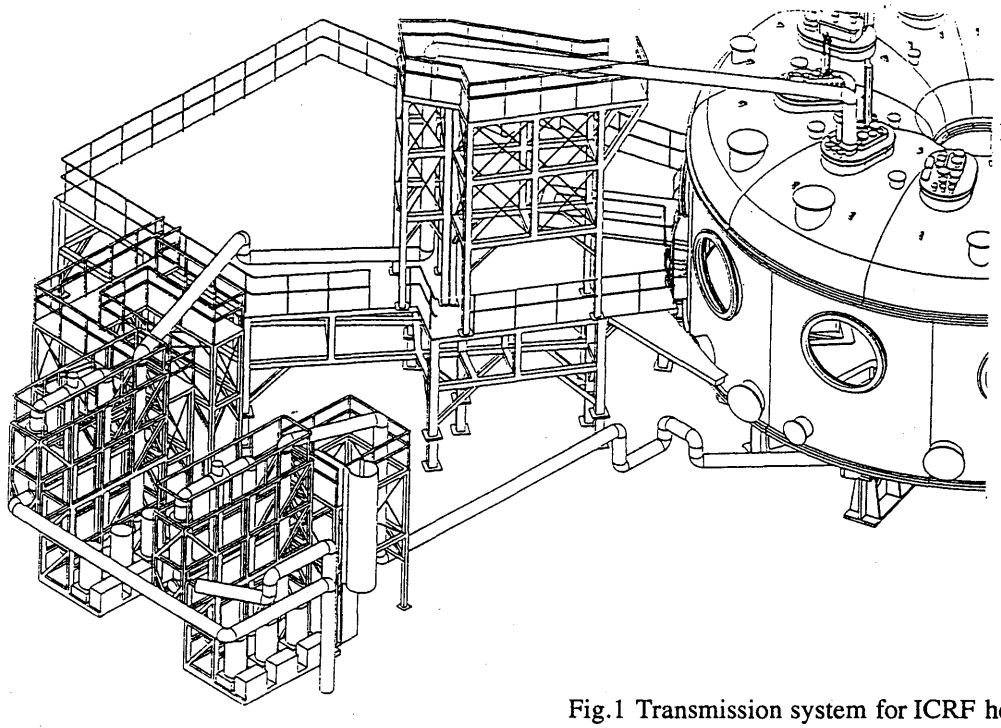

Fig.1 Transmission system for ICRF heating power.