§32. RF Voltage Reduction by Pre-stub Tuner

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We are developing an ICRF heating power transmission system described in previous sections. During the development, sometimes RF breakdown occurred on the transmission system, which was caused by the RF breakdown along the surface of a Teflon insulator. The reduction in RF standing wave voltage raises the reliability of the transmission system. Then we tested the pre-stub tuner effect on ICRF heating R&D system as shown in Fig.1 in the previous section. The pre-stub tuner is located between RF antenna and impedance matching circuit. By selecting its proper location, it works remarkably to reduce RF standing voltage between the pre-stub tuner and the impedance matching circuit[1]. When the RF voltage can be reduced, the power dissipation due to Ohmic resistance reduces and the reliability of whole RF transmission system rises.

We confirmed the RF voltage reduction by the pre-stub tuner by calculation. The reduction ratio can be determined by the pre-stub tuner position and its normalized length. Figure 1 shows how RF voltage can be reduced by the pre-stub tuner, where the effect is expressed by the dependence of reduction ratio of RF voltages in front and behind the pre-stub tuner on the normalized length of the pre-stub tuner, A_p. The voltage reduction effect increases as the pre-stub tuner becomes shorter. When the pre-stub tuner is 0.052, the RF voltage can be reduced to one third.

The pre-stub tuner effect was experimentally demonstrated. RF voltages were measured at three points between the impedance matching circuit and the pre-stub tuner and one point between RF antenna and the pre-stub tuner. Figure 2 shows the RF standing wave voltage distribution, when the normalized length of the pre-stub tuner is 0.25. The RF voltage reduction is not seen. On the other hand, the RF voltage reduction can be seen in Fig.3, when the normalized length of the pre-stub tuner, A_p is 0.052. The pre-stub tuner was located at 12.25m as shown in Fig.3, where the length is measured from the point of the stub tuner located at antenna-side. It is clear in this figure that the RF standing wave voltage can be reduced to V_{pre}=19.5kV, which is one third of maximum RF voltage near RF antenna, V_{ant}=58kV. It is important to obtain such RF voltage reduction so that the position of the pre-stub tuner should be selected for the RF voltage to become low. The RF dissipation loss due to Ohmic resistance can be reduced to one tenth and the temperature increase in the outer transmission line becomes smaller.

Reference

1)Kumazawa, R.,Mutoh, T., et al., Annual Report 1993-1994, p.72.

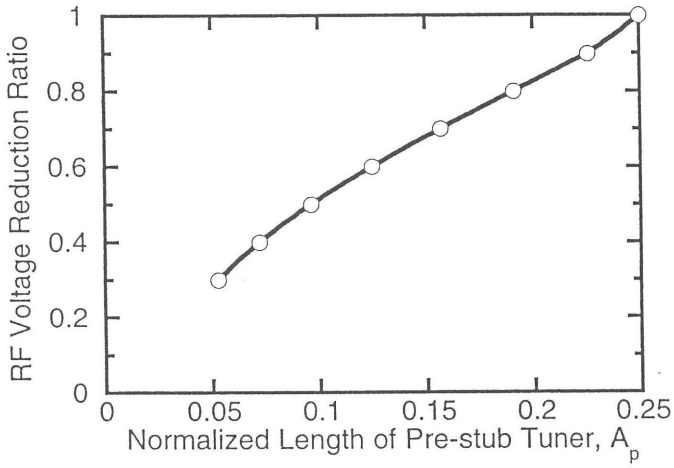

Fig.1 Dependence of RF voltage reduction on normalized length of pre-stub tuner, A_p.

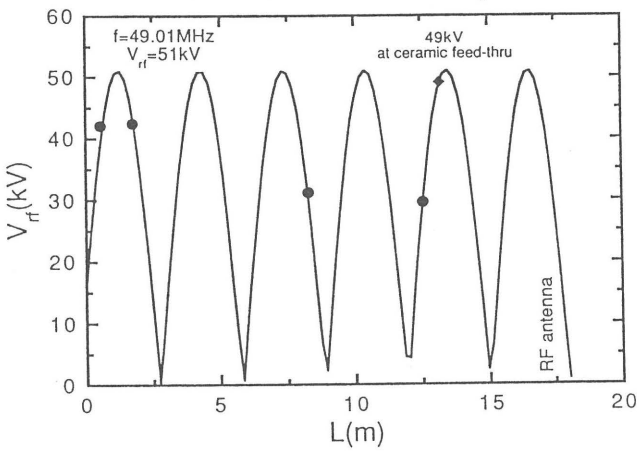

Fig.2 RF standing wave distribution without pre-stub tuner effect in 51kV operation.

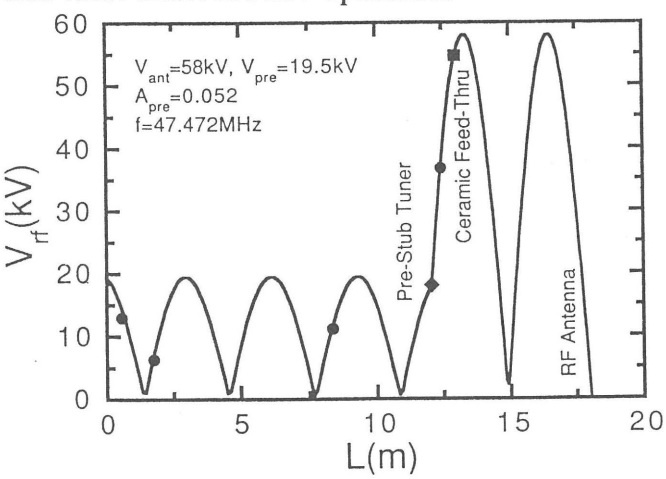

Fig.3 RF standing wave distribution with pre-stub tuner effect in 58kV operation.