§34. RF Stand-off Voltage Test of the Co-axial Transmission Line with Different Kinds of Gases

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In the transmission line of ICRF heating system, there is a large voltage standing wave between the antenna top and the impedance tuners. To withstand this high RF voltage, the insulation gas is pressurized in the lines. Usually sulfur hexa fluoride (SF6), carbon dioxide (CO2) and nitrogen gas (N2) are used for insulation gas. However there is no explicit data comparing these gases in a same experimental setup in ICRF range.

In LHD ICRF heating system, the coaxial transmission line has a large diameter of 240mm. Even in this large transmission line, if any breakdown happened, some damage occurs on the Teflon spacer plates. Therefore the design of spacer is also an important issue. RF breakdown is thought to be triggered from the point of locally highest electric field. That is usually at the corner of the spacer supporting parts of the conductors. To reduce the electric field at the corners between the Teflon insulator and the conductor, we introduced the design concept which was developed by JAERI ICRF group. The cross section of the straight co-axial transmission line for steady state and high voltage use is shown in Fig.1. The above mentioned optimization is seen at the recess structure on the Teflon plate.

The stand-off voltage test was done at 40MHz with a short circuit without antenna. The length of the short circuit is about 8m. In this experiment, the 1st tuners was a liquid type tuner. The filling gas pressure was 3 atmosphere. After the set up of the system, the RF voltage and the pulse length were raised step by step. These test paths are shown in Fig.2. First test was done by using SF6 gas. RF voltage was raised at the pulse length of 0.1 second, then pulse length was increased up to 1800 second. The path is shown by dotted line. The cases of CO2 and N2 are shown by solid line and double solid lines respectively. In the case of CO2 gas, the stand off voltage is less than other two gases. Break down was observed several times on the way to the maximum point at 10 sec and also at the points of several minutes. Therefore, there is no data in CW operation in CO2 gas case. By using nitrogen gas we can obtain the almost same data as with SF6 gas. The difference at the 30 minutes is not due to the breakdown. We just stopped due to anxiety.

The breakdown with SF6 gas makes a lot of dirty decomposition products and toxic gas in CW mode, so N2 gas should be more favorable in LHD experiments.

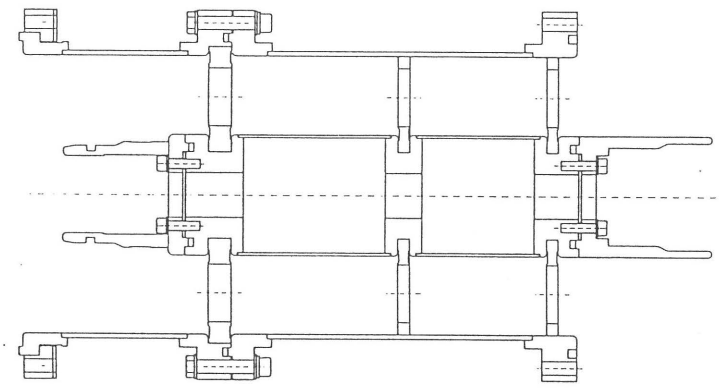

Fig. 1 Drawing of straight transmission line with Teflon spacers. Cooling water flows inside the center conductor and the space between the conductors is filled with insulation gas.

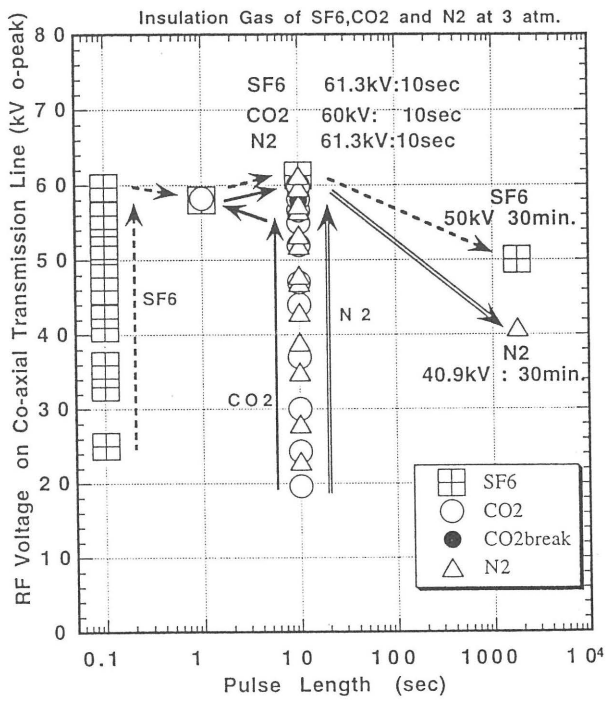

Fig.2 Peak RF voltage on the transmission line and the pulse length with different insulation gas. Test procedures are shown by arrows.