Modification of Modulating Anode Voltage Supply of Klystron for PEFP 20 MeV Linac*

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1. Introduction

The klystron (TH2089F, THALES) for PEFP 20MeV proton linear accelerator has a triode type electron gun and the modulating anode voltage should be supplied. The klystron has gone through some modification in the modulating anode voltage supply circuit [1].

Formerly, the mod-anode voltage was supplied by using the tetrode-controlled voltage divider. This system requires addition power supply for the tetrode and the grid control circuit. Recently we modified the mod-anode supply from the tetrode-controlled voltage divider to a resistive voltage divider.

The resistors for the previous voltage divider were installed at a supporter with high voltage bushing structure next to the klystron. In the previous system, the resistors were exposed to the air and their size was very bulky, length of which was about 1m long. To reduce the space occupied by the voltage divider and to improve the electrical insulation performance, the voltage dividing resistors were moved into the oil tank of the klystron. During the operation of the 20 MeV linac, the klystron parameters were measured [1][2]. In this paper, the modification of the voltage divider and the operational characteristics of the klystron with modified voltage divider circuit are presented.

2. Power Rating Measurement

2.1 Dividing Resistor

The characteristics of a resistor (SR60HVP, E&C) used for the voltage divider are shown in Table 1. Before installing the voltage divider in the oil tank, the power rating of a resistor must be checked because degradation of power rating is inevitable with reduced size of the resistor [2].

Table1. Characteristics of Resistor

	Rated power [W]	Operation temperature range[℃]	Dimensions [mm]		Resistance tolerance [%]
			Length	Diameter	
SR60HVP	10	-25 ~ 125	200±2	23±0.5	±1

2.2 Power rating experiment

The circuit for the power rating experiment is simply composed of a resistor and a power supply as shown in Figure 1. One of the thermometers measured the temperature of an insulator body of the resistor and two other thermometers were used to measure the ambient temperature of the air and oil temperature, respectively.

The temperature rise of the SR60HVP 8MΩ was saturated at 52.3 deg. C with its rated power of 10 W in the air. When the resistor is immersed in oil, the temperature remained below 60 deg. C with 60 W dissipation for more than 12 hours, which is well over the rated power. This high power dissipation is expected value of normal operating condition during the klystron operation. The results of the power rating measurement showed that the power rating of the resistor can be increased by 5 times when the resistor is soaked in the oil.

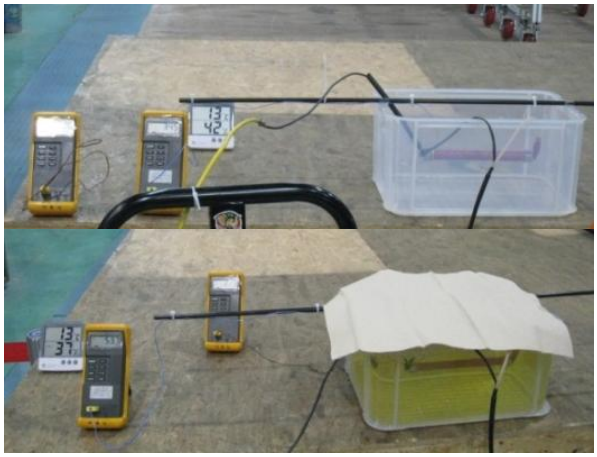

Figure 1. Resistor test in the air(upper side) and the oil(bottom side)

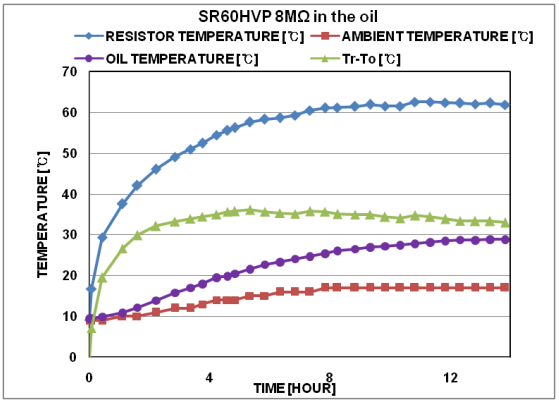

Figure 2. Power vs. Temperature about SR60HVP 8MΩ in the oil.

3. Installation in the Klystron Oil Tank

The voltage dividing resistors which were installed in the klystron oil tank were connected in parallel with the klystron load to produce the modulating anode voltage by using the applied cathode voltage. The installed resistor and block diagram of the mod-anode are shown

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in the Figure 3 and Figure 4, respectably.

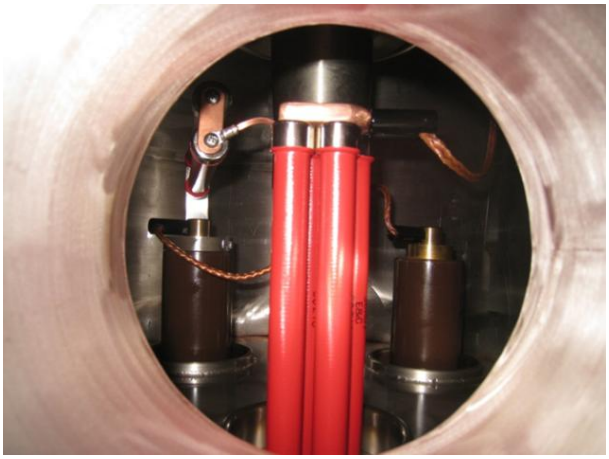

Figure 3. The voltage dividing resistors installed in the klystron oil tank

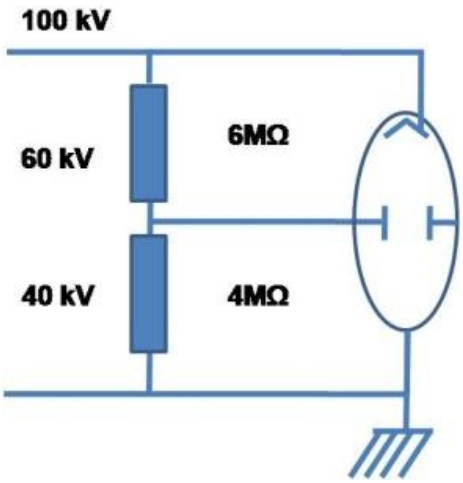

Figure 4. Mod-anode block diagram

4. Measurements

During the 20-MeV linac operation, the beam perveance and RF gain were measured to check the impact of the modification of the modulating anode voltage supply. The results of the measurement with two different dividing ratio cases are summarized in Table 2. The measured values were slightly different from the FAT values, which were 0.68 uperv. and 41 dB respectively.

Table 2. Summarized results in the klystron operation

Resistor [Mohm]	6 : 4	6 : 4.5
Beam perveance [uprerv.]	0.74	0.74
RF gain [dB]	49.4	50.0

5. Conclusion

The voltage dividing resistors for the modulating anode voltage supply were installed in the klystron oil tank. During the klystron operation, the klystron perveance and RF gain were measured and showed slight differences from the FAT values. The klystron perveance and RF gain require further optimization for better performance and the dividing ratio of voltage divider should be adjusted and checked.

ACKNOWLEDGMENT

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REFERENCES

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[2] Dae-Il Kim, et al., "Power rating measurement of the voltage divider resistors for the klystron modulating anode" Transactions of the Korean Nuclear Society Spring Meeting, Pyeongchang, Korea, May 27-28, 2010

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