Power Rating Measurement of the Voltage Divider Resistors for the Klystron Modulating Anode

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1. Introduction

The 20MeV Proton Linear Accelerator is driven by two of klystrons [1]. The electron gun of the klystrons is triode type with modulating anode. The resistors for voltage divider of modulating anode were installed at supporter including the insulators next to klystrons. The voltage dividing resistors for the klystron at the 20MeV proton linear accelerator are composed of the resistor of five of 1MΩ, two of 0.5MΩ. These resistors are exposed to the air very bulky whose length is about 1m. To improve the voltage dividing resistor, the resistor will be in the oil tank of heat cathode. For putting in the oil tank of heat cathode, the size and properties of matter of the resistor must be small in former thing and durable about the oil. In addition, it is important to confirm the power rating of resistor because of reducing the power rating about reducing the dimension. The characteristics of resistor are shown in the Table1.

Table1. Characteristics of Resistors

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

2. Heat Transfer Coefficient Calculation

To confirm the power rating of resistor, the heat transfer coefficient in air, oil and water is calculated using the thermal conductivity, Nusselt number and resistor diameter from the properties of table. The calculated results are shown in the Figure1 [2].

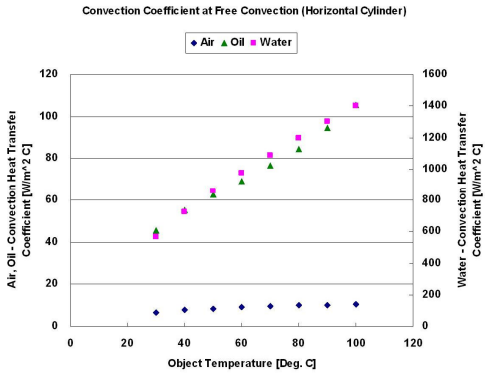

Figure1. Convection coefficient at free convection in the air, oil and water

2. Experiment

The circuit is simply composed of a resistor and a power supply. One of the thermometer is measured by contact to an insulator of resistor and another is measured the ambient temperature in the air and oil. This test is composed of two of thermometer (FLUKE, 50D K/J), a simply temperature and humidity device, a see-through box for the oil, power supply (KSC, 30kV/20mA). The resistor test in the air and the oil is shown in the Figure 2.

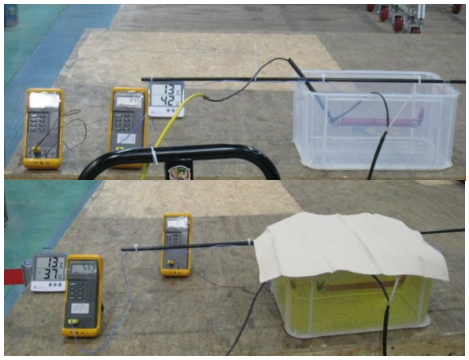

Figure2. Resistor test in the air(upper side) and the oil(bottom side)

3. Measurement

First, the temperature of resistor depending on power is measured in the air by to increase the drive voltage until the power reached 120 % of the rated value is saturated the temperature up to the rated power. The results are shown in the Figure 3.

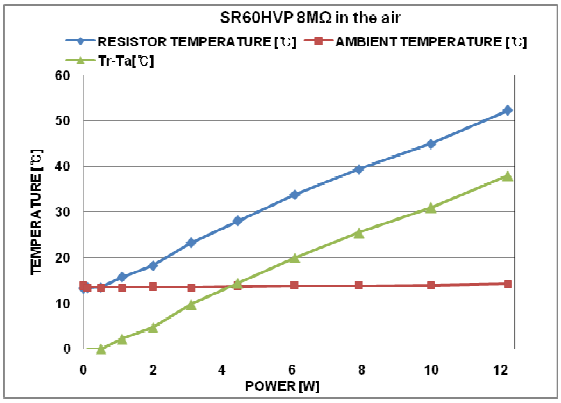

Figure 3. Power vs. Temperature about SR60HVP 8MΩ in the oil.

The temperature of resistor is also measured in the oil by increasing the drive voltage when is saturated the temperature up to about 60 W which is to consider the klystron duty when is the 24%. And the result is shown in Figure 4.

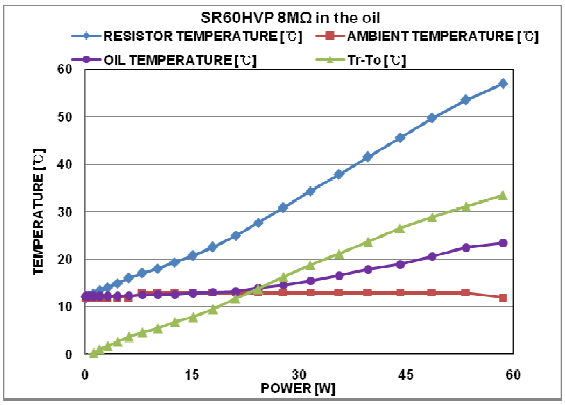

Figure 4. Power vs. Temperature about SR60HVP 8MΩ in the oil.

Second, the SR60HVP in the oil is measured the temperature at an interval of about 30 minutes in the 22kV of drive voltage when is the 60W to confirm the saturation level. The results are shown in the Figure 5.

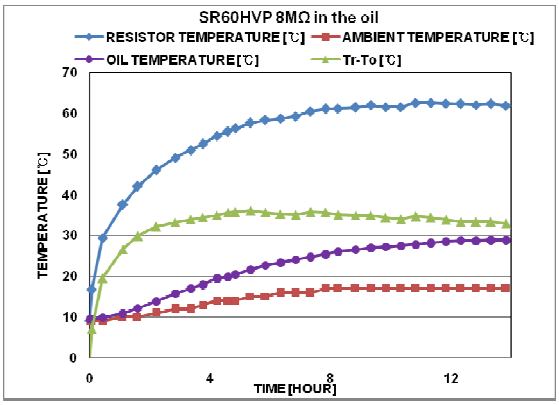

Figure 5. Power vs. Temperature about SR60HVP 8MΩ in the oil.

Third, to confirm the difference in calculated convection coefficient, the deviation temperature of resistor in the air and the oil is computated the data. The deviation temperature of resistor in the air should be more than in the oil. The result is shown in the Figure 6.

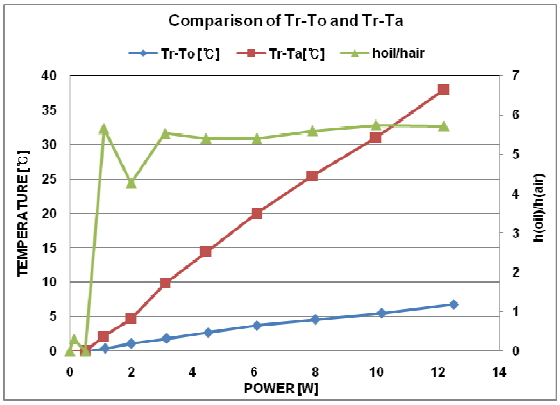

Figure 6. Comparison of difference in the resistor, air and oil about SR60HVP 8MΩ in the air and oil.

4. Results

The SR60HVP 8MΩ is saturated at 52.3 degrees when is the rated power in the air and 57 degrees when is the 60W which is a resistor over power dissipation to consider the klystron duty 24% in the oil. The one in drive voltage of 22kV when is the 60W of rated power are saturated at about 61degrees during the 12 hours. The difference in temperature of the resistor and the oil is about 34 degrees in the equilibrium conditions. The ratios of calculated and measured heat transfer coefficient in the air and the oil are 6 and 5.5, respectively. In the result, the deviation temperature of the resistor in the air and oil is confirmed to extend the power rating of the resistor.

ACKNOWLEDGMENT

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REFERENCES

[1] H. J. Kwon, Y. S. Cho, H. S. Kim, J. H. Jang, Y. H. Kim, K. T. Seol, I. S. Hong and Y. G. Song, "Test Results of the PEFP 20-MeV Proton Accelerator", LINAC'06, Knoxville, p. 133 (2006)
[2] J. P. HOLMAN, Heat transfer (McGraw Hill, METRIC EDITION), chapter 1