Installation and Commissioning of the Resonant Frequency Control Cooling System

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1. Introduction

A 100-MeV proton linac which includes a 50-keV ion source, a 3-MeV RFQ (Radio Frequency Quadrupole), and a 100-MeV DTL (drift tube linac) was developed [1]. Total 11sets of Resonant Frequency Control Cooling System (RCCS) are used to control the resonance frequency of the 100-MeV DTL. The specifications of the RCCS are summarized in Table 1. As shown in the Table, the RCCS should cover the temperature from 21°C to 33°C, heat load from magnet power only to full RF power in addition to the magnet power. The stability of the temperature control is less than 0.1°C. The control input variable comes from the resonance frequency error from the low level RF (LLRF) system. All RCCSs were installed and tested. In this paper, the installation and initial test results of the RCCS are presented.

Table 1: RCCS specification

Parameters	Values
Operating temperature	21°C ~33°C
Temperature stability	0.1°C
Chiller temperature	10°C ±0.2°C
Heat load (RCCS21 case)	Only magnet (75kW) ~ Full RF + magnet (95kW)
Valve	3-way mixing valve
Control	EPICS
Resistivity	> 1MΩ cm

2. Installation

All the RCCSs are installed. Each DTL tanks requires independent RCCS for its resonance frequency control. The RCCSs were installed at 2nd floor of the accelerator building whereas the DTL were installed at 1st floor. The RCCS consists of variable speed pump, heat exchanger, 20kW heater to supply the heat load at low duty operation of the DTL, two sets of 3-way valve to control the cooling water temperature and demineralized water (DI) system which is planned to treat 1% flow rate of the RCCS. All components were installed on the skid plate and the size and RCCS is 2m (W) × 2.2m (D) × 2m (H). The installed RCCS is shown in Figure 1. The utility interfaces of the RCCS are DI water supply to the primary side, N2 system to the surge tank, and chilled water at secondary side. All the piping works to the utility and DTL tank were finished in addition to the cab ling works.

Figure 1: Installed RCCS

3. Initial Test

The standalone test of the RCCS was carried out before the connection to the DTL to check its control characteristics by using the new built utility system. One chilled water system supplies 10°C water to all the RCCS and 3 sets of constant temperature cooling skid. First, the chiller was tested in conjunction with the RCCS and cooling skid. During the test, all the heaters of the RCCS and cooling skid were operated because the chiller needs heat load for proper operation. The total heat load by using the internal heater was 350kW. In such conditions, the chilled water temperature at the outlet side of the chiller fluctuated from 8°C to 12°C with 4.5 minutes period whereas the temperature at the inlet side of the RCCS fluctuated from 11°C to 12°C with the same period as shown in Figure 2. The chilled water temperature was controlled by only the internal PID control algorithm which was not tuned optimally yet. The RCCS temperatures with 50% openings of each 3-way valve are shown in Figure 3. The fluctuation period was the same to the chilled water temperature and the temperature deviation was ±0.25 °C as shown in Figure 3. Second, the 3-way valve controller was tuned to estimate the proper PID control values. It used the relay method by using the internally programmed algorithm. After the controller tuning, the system could be operated with a temperature deviation less than ± 0.1°C with only primary control valve or both control

valve at primary and secondary side. The results are shown in Figure 4 with various operation conditions.

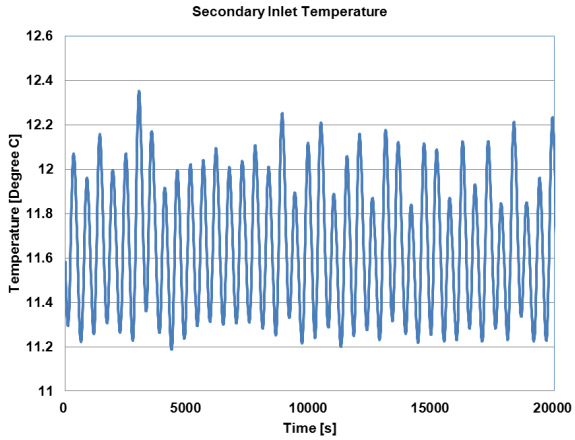

Figure 2: RCCS secondary side inlet temperature

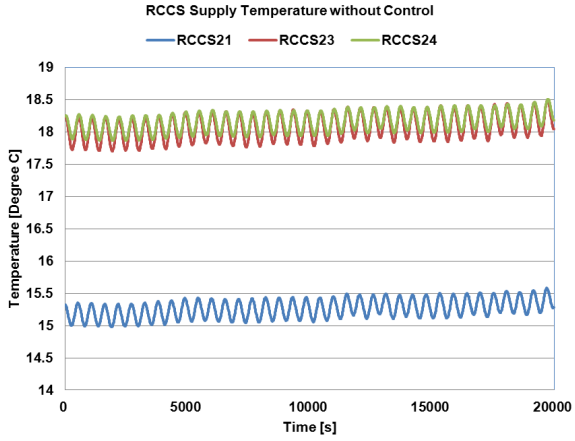

Figure 3: RCCS supply temperature without control (50% opening of both 3-way valve)

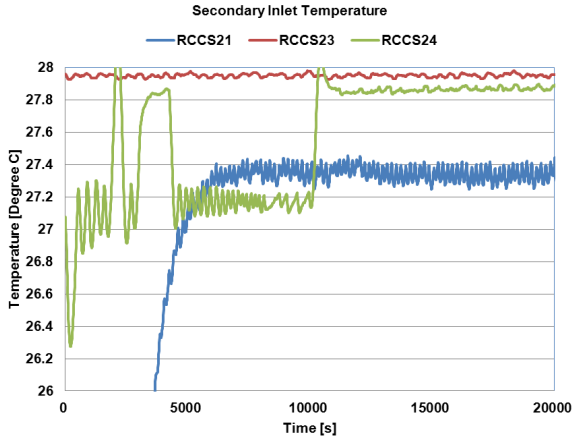

Figure 4: RCCS supply temperature after PID tuning at various operating temperature

4. Conclusions

The standalone test of the RCCS for 100-MeV DTL was carried out. The results showed that the chiller temperature fluctuated above the specification mainly because the chiller controller was not properly tuned, but the RCCS with two independent control valves could be operated to give the required stability.

ACKNOWLEDGEMENT

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REFERENCES

[1] K. Y. Kim, Y. S. Cho, J. Y. Kim, K. R. Kim, and B. H. Choi, “The Proton Engineering Frontier Project: Accelerator Development”, JKPS, vol. 56, p 1936, 2010.