HORIZONTAL HIGH PRESSURE WATER RINSING FOR KEKB SUPERCONDUCTING CAVITY

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Abstract

Usually, high pressure water rinsing of superconducting cavity is performed at vertical position to vent water and dusts smoothly. In KEKB cavities, there is a possibility that the cavities are contaminated with dust particles. To remove those contaminants at online tunnel, although the baking should be avoided because of many indium joints, horizontal high pressure water rinsing (HHPR) would be useful. We have tested HHPR using KEKB proto type niobium SC cavity with 60 bar ultra pure water and an aspirator pumping system. Even without any baking, the cavity cleaned with HHPR achieved an accelerating field of 10 MV/m in a vertical cold test. The performance was similar to one before HHPR.

INTRODUCTION

B-Factory at KEK (KEKB) has been operated about ten years since 1999 with 8 superconducting cavities for the high energy ring (HER). The KEKB HER has been operated with the maximum current of 1.4 A and the maximum HOM power of 13 kW. These values are higher than the designed parameters. Therefore a coupling constant of high power coupler has been changed several times to correspond to higher current and power. At the time, the degradation of the performances of cavity such as E_{acc} and Q values occurred possibly due to particle contaminations. In the current operating conditions of KEKB, those degradations of performances are acceptable. In the future project of super-KEKB (SKEKB) which is planned to operate with further higher beam current more than 2 A, the degradation will have to be removed in order to operate with those cavities. In consideration of the long term operation of SKEKB, a performance recovery system will be demanded to remove the particle contaminants from the cavity surface.

The KEKB cavity can take out from the cryostat without disassembling welding joints however it takes long time and needs to exchange many metallic gaskets and indium joints. A horizontal high pressure water rinsing (HHPR) system is useful to clean the cavity inside without disassembling the cavity seals. In that case, however, the baking with high temperature should be avoided to protect the indium joints.

We have started to study of the ultra-pure water HHPR system equipped with a long rotatable nozzle and a pumping out nozzle for water. In this report, we describe the trial HHPR and the result of vertical test of the rinsed cavity without baking.

HORIZONTAL HIGH PRESSURE RINSING SYSTEM

The conceptual design of the HHPR system is shown in Fig.1. The ultra-pure water was pressurised by a reciprocating pump to 60 bar and filtered by a fine filter of 0.5 µm. The nozzle has 6 holes made every 60 degrees at the end. Rotation of the nozzle of 60 degrees in five seconds about the cavity centre axis can sweep all angler position. The nozzle was moved along the cavity axis manually. The moving steps were 10 mm for the beam pipe area and 5 mm for the cavity cell area in 15 seconds.

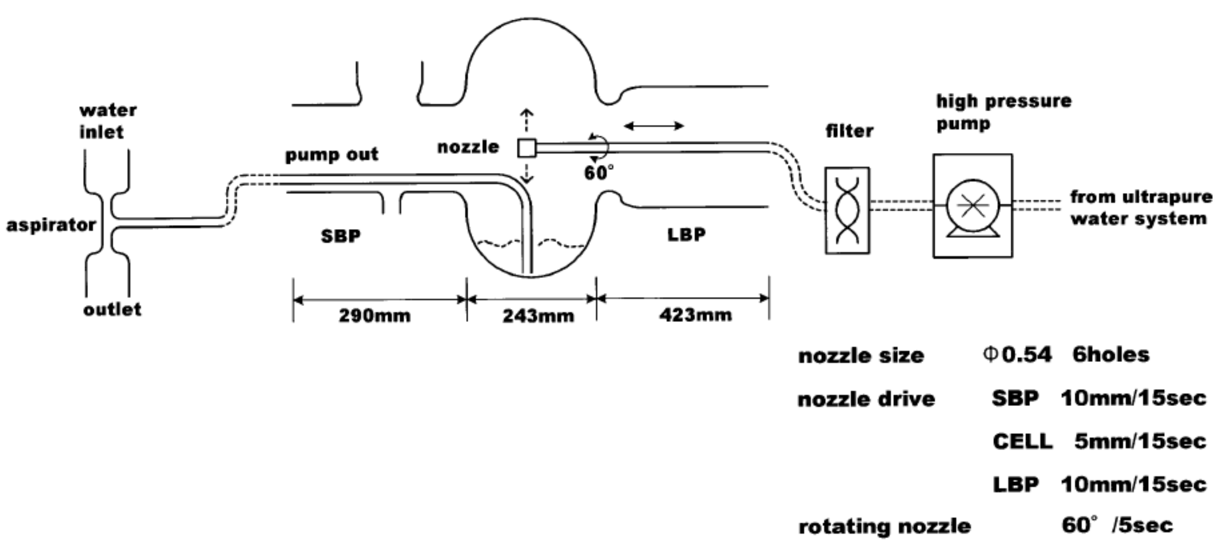

Figure 1: Conceptual design of horizontal high pressure water rinsing system.

The water trapped in the cell was pumped out by the aspirator pump which can handle water and air mixture. The total rinsing time was about 20 min. Fig. 2 shows the nozzle of HHPR and Fig. 3 shows magnified part of the nozzle. The nozzle was made of SUS 410 that is hardened

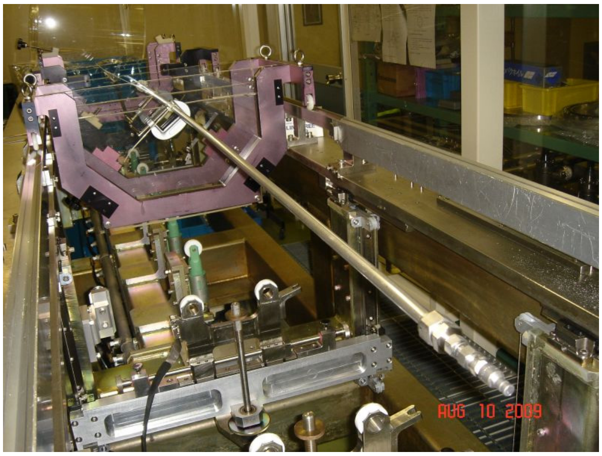

Figure 2: Long nozzle for HHPR guided by rails.

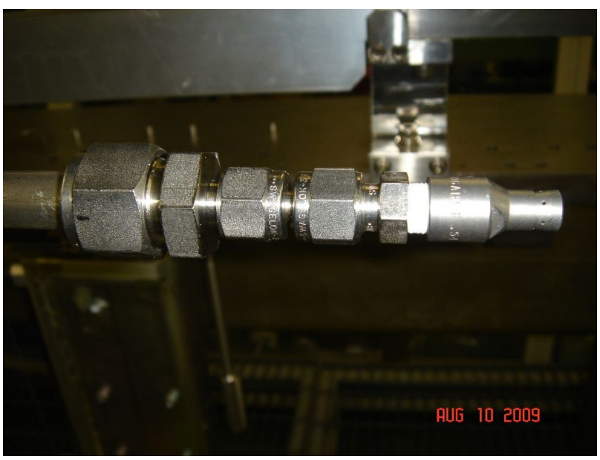

Figure 3: Nozzle head of HHPR.

Figure 4: HHPR test at KEKB clean room.

by martensitic transformation. The HHPR was carried out in the KEKB clean room as shown in Fig. 4 using a prototype test cavity which was electro polished and baked in advance. Before and after the HHPR, the nozzle holes were observed by a digital microscope. They had no crack and deformation during HHPR.

After HHPR, the cavity was evacuated at a vertical test stand. Therefore residual water flowed down to a LBP flange for this time. Certain amount of water should be evacuated by only scroll type vacuum pump (Varian Co.) which has ability to evacuate water, taking about one over night. After that a turbo molecular pump (TMP) was started and the pressure of cavity was of the order of 10^{-4} Pa with the scroll pump and TMP. And the pressure of cavity reached 7×10^{-6} Pa with an ion pump even without any baking.

VERTICAL TEST AND DISCUSSION

The vertical test was carried out for the cavity. The cavity was cooled by liquid nitrogen from room temperature to about 100 K and kept 100 K for one night as precooling. And then the cavity was further cooled by liquid helium from 100 K to 4.2 K within 1 hour. The liquid helium was filled over the cavity top. The RF input coupler set at top position should be immersed in liquid helium to avoid discharge in the cavity.

The measured Q-E_{acc} curve is shown in Fig. 5. The maximum field reached 10 MV/m almost same as the previous experiment. After reaching 10 MV/m, the field decreased to 6 MV/m as shown as open circle of Fig. 5. This was expected some discharges happened inside the cavity due to liquid helium level was reduced below input coupler position. It is a reason that we tried to increase the field, although the low liquid helium level was measured with a superconductor level sensor.

The results that the field reached 10 MV/m without any baking after HHPR and the cavity could be evacuated with the oil free roughing pump with long pumping time are encouraging facts for our KEKB cavities.

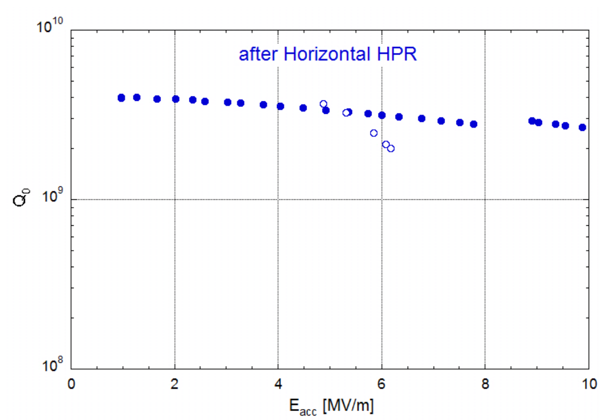

Figure 5: Q-E_{acc} curve measured after HHPR

CONCLUSION

KEKB prototype Nb cavity which was baked once after the electro polishing was cleaned with HHPR as a trial. The maximum electric field of the cavity reached 10 MV/m without baking. We are planning further experiment fully assembled cavity with a high power coupler and indium joints. This type of HHPR system might be useful for SRF cavities of Super KEKB, and also for many same type cavities of synchrotron light sources.

ACKNOWLEDGEMENT

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REFERENCES

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