Test results of a proto-type sector chamber of the PLS storage ring

C.D. Park, Y.J. Han, H.J. Kim, H.S. Youn and W.C. Choi

Vacuum Lab., Storage Ring Div.,Pohang Lignt Source
Pohang Institute of Science and Technology

INTRODUCTION

A proto-type sector vacuum chamber has been fabricated, assembled and tested with the aim of predicting the performance of the vacuum system of the PLS storage ring. The chamber has been designed to maintain a static pressure of $1x10^{-10}$ Torr. This paper describes how the chamber assemby and tests have been done.

VACUUM SYSTEM

The proto-type sector chamber which was made by welding two machined aluminium plates, is about 10 meters long. The chamber material is A5083-H321. The total surface area of the chamber is approximately $6x10^4 cm^2$. Assuming a specific thermal outgassing rate of $5x10^{-12}$ Torr·l/s/cm^2, then a total thermal gas load is $3x10^{-7}$ Torr·l/s.

The chamber is pumped by non-evaporable getter pumps(NEG's) and sputter ion pumps (SIP's). The combination pumps, consisting of lumped NEG and SIP, are installed under the photon stops. Since the vacuum system for the sector chamber has been designed to maintain a static pressure of $1x10^{-10}$ torr, the total pumping speed should be in the range of 2000 liter/sec.

Vacuum monitoring is done by one convectron, two ion gauges, and five SIP current measurements. Pressures in the ultra-high vacuum range are read with Bayard-Alpert ionization gauges. Pump currents can be used to give an indication of local pressure. A residual gas analyzer is installed to monitor partial pressures.

Metal O-rings, so-called Helicoflex seals, are used between the aluminium vacuum chamber and stainless steel spools. Vacuum components such as pumps and gauges are connected to the sector chamber via spool pieces

CHAMBER ASSEMBLY

After machining the two halves of the chamber, a non-immersion chemical cleaning was carried out. The procedure used was : steam clean for oil removal, scrub the surface with alkaline cleaner, rinse with copious amounts of de-ionized water, and blow dry with liquid nitrogen boil-off.

The top and bottom parts of the chamber were aligned before welding with alignment tools to insure optimal distribution of errors. The mid plane of the chamber was joined using TIG weld. Stainless steel spool pieces including blank off flanges were installed and leak tested with the detection limit of $1x10^{-10}$ Torrl/s.

The chamber was then installed onto the girder using a support system. Finally, combination pumps, vacuum gauges, and roughing units were assembled onto the chamber and leak tested again.

VACUUM PERFORMANCE

Roughing from atmospheric pressure down to $1x10^{-5}$ Torr was done by oil-free turbomolecular pumping unit. The chamber deformation due to the pressure difference between inside and outside of the chamber was acceptable.

The vacuum chamber was vacuum baked to 150°C using hot water circulating through two copper tubes embedded on the chamber surfaces. The temperature distributions show the highest of 143 °C and the lowest of 102°C. The temperature gradients can be considered acceptable. This implies that no thermal insulations are necessary. The chamber expanded 25mm longitudinally during bakeout and the transverse deflection at the exit end of the chamber was 3.5mm. Additional chamber supports are necessary and magnet pockets at the exit end of the chamber should be re-designed in order to prevent the chamber from interfering with magnets.

Lumped NEG modules were activated at the end of bakeout. We spent rather long time for actvation to maintain the chamber pressure less than $5x10^{-6}$ Torr. The modules were connected each other in series to keep the current low and activated simultaneously with one power supply. The current was set at 37 amperes to activate at 450 °C. The temperature anywhere in the chamber during activation were kept less than 150°C. This means no additional cooling is reqiured.

The pressure reached $3x10^{-9}$ Torr. Considering the expected thermal load and the pumping speed, the pressure was not in the designed range. Air leaks through Helicoflex seals were found after bakeout. It is considered Helicoflex seals used are defective. Performance test for the chamber should be done with new Helicoflex seals. Various tests of Helicoflex seals are in the process to get data for a proper vacuum sealing.

An alternative sealing method is now being tested to minimize the use of Helicoflex seals. Aluminium half nipples with conflat flanges made of A2219 will be directly welded onto the chamber where a small welding deformation is acceptable.