Maintenance of vacuum equipment of accelerators

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This annual report shows the maintenance of vacuum equipment in accelerators in 2017.

First, the maintenance procedure of vacuum equipment in RILAC is described. The worst condition of vacuum in RILAC was in cavity No.5. The pressure of the vacuum in the cavity was 1.0×10^{-3} Pa in February 2017. Vacuum leak points were investigated using a helium leak detector. However, the location of the leak point was not identified because the behavior of the helium gas was complicated. In November 2017, an inner cylinder and a drift tube in cavity No.5 were investigated. The drift tube was placed on the inner cylinder. The space outside the inner cylinder was vacuum and the space inside the cylinder was atmosphere. A gap between the drift tube and inner cylinder was sealed using an O-ring. To find the location of vacuum leak, a dye penetrant inspection material was used. Accordingly, the vacuum leak point was found in the O-ring between the drift tube and inner cylinder. Although the O-ring should be replaced with a new one, it was a special product and there was no spare. An order was thus passed to a supplier (Sumitomo LTD) for an O-ring.

The maintenance of vacuum in cyclotrons was carried out as follows. At AVF, in January 2017, as a compressor of a cryopump did not work so that a turbo molecular pump (TMP) was installed in place of the cryopump, and the AVF was pumped down through the TMP. In February 2017, a vacuum leak was detected at an insulator of RF No.2, and the corresponding O-ring was replaced with a new one. The pressure of the vacuum was thus improved. In August 2017, a broken angle valve connected with a TMP in DTL was replaced with a new one. The RIKEN ring cyclotron (RRC) showed leaks at two locations: one at the bellows connected with RF No.2 and another was due to a pressure increase of 1.2×10^{-5} Pa in N-sector. The leak in the bellows was treated with a sealing agent, however, the location of the leak point was not confirmed. The N-sector was divided into two spaces separated by a membrane with one part in high vacuum and the other in low vacuum. The pressure in the high-vacuum which was in the order of 10^{-5} Pa, could not be decreased. Although the location of the vacuum leak was checked using a helium leak detector, the leak point was not found. If there was no leak outside the N-sector, the space of high vacuum would be connected with that of low vacuum. The helium leak detector was connected to the space of low vacuum. When helium gas was inleted into the space of high vacuum, the leak detector reacted. Thus the connection between the two spaces was confirmed by creating holes in the membrane. As such gas in the low vacuum space flows into the high vacuum space through the holes. However, the condition of the membrane could not be known. To confirm the condition, a Dee of the N-sector was removed in August 2017. The location of the leak point in the bellows and the connection between the spaces of high and low vacuum were investigated. When the Dee was removed, a crack on the surface of the bellows was confirmed. To solve this problem, the bellow should be replaced with a new one. However a large-scale repair work is needed to replace the bellows; this requires a considerable amount of time and a huge budget. Therefore, the vacuum leak at the bellows was tentatively treated with a sealing agent. Moreover, the inside of the Dee or N-sector could be observed after the removal of the Dee. Two holes were confirmed on the membrane. Gas in the low vacuum space flowed into the high vacuum space, and the pressure in the high vacuum space increased. The ion beams were deviated from orbit and hit the membrane, thus creating holes. Therefore, the problem of high pressure in the space of high vacuum must be solved. To decrease the pressure in the high-vacuum space, the pressure in the low vacuum space was reduced. This reduction in the high-vacuum space occurs because inlet flow of gas from the space of low vacuum reduces with pressure reduction. To reduce the pressure in the space of low vacuum, a TMP with a pumping speed of 50 L/s, connected to this space was replaced with a TMP of larger pumping speed of 220 L/s. After replacing the TMP, the pressure in the high-vacuum space was reduced in the order of 4×10^{-6} Pa.

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