Vacuum leak problem in low energy of pelletron

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During unit wise conditioning of unit # 8, the vacuum started deteriorating inside the tube after a spars. The RGA reading was taken and it was found out that residual gas inside tube was sulphur hexafluoride. A leak was detected in second tube of unit number eight in between electrode 6 to 8. Leak was sealed with the sealant. Again leak check was done and no leak was found. The tank was closed and conditioning was started again. During the same unit number eight conditioning, leak developed again followed by a spark. So the damaged tube was replaced with a new accelerator tube.

During the installation time the alignment of the machine was taken care. Again leak checking was done and the tube was baked properly. The tank was closed again and this particular unit was conditioned for about four days. The maximum voltage it has attained was 1.1 MV.

1 Introduction

15 UD pelletron, at NSC, consists of 30 units, 15 each on either side of terminal. Accelerating tube in single unit of pelletron accelerator in Nuclear Science Centre consists of 37 electrodes. Three 11 gap tubes and half of 8 gap tube make up this number. The other four electrodes of 8 gap tube and three 11 gap tubes then come in subsequent unit. Unit # 8 and unit # 9 form one such unit. The location of this section of tube is just above dead section 1.

To achieve high voltage on the terminal it is required to condition the units by putting high voltage gradients on the units separately. The main physical process that occurs during the conditioning is that the gas adsorbed on the surface of the tubes comes out which is pumped out. Occasionally, forced conditioning is also done, where the voltage gradient is increased at the rapid rate, beyond the level up to which conditioning has been done, allowing the boil off of the gas, and then bringing it down quickly before a spark can occur. This procedure allows conditioning to be done quickly and effectively. Sometimes, sparks in an individual unit are also allowed to occur to have a beneficial effect on the ultimate voltage achieved by boil off of some adsorbed gas in a particular region.

Unit-wise conditioning is done by shorting all units but one on which voltage is desired to be put.

2 Development of Leak

During unit-wise conditioning of unit #8, there was lot of CPO activity and in all there were 21 sparks. The vacuum started deteriorating after a spark. The vacuum of IP022 went as bad as $2.2 \times 10^{-7}$ and vacuum of IP_T1 instead of coming down, it remained constant on $3.0 \times 10^{-7}$.

It was inferred that there has been a leak development and it was decided to open the tank to detect and seal the leak. To study the nature of the leak the vacuums of all the ion pumps above terminal were monitored and RGA reading for SF6 (mass 127 amu) and moisture (mass 18 amu) were taken. This was done by stopping the gas handling in between several times and starting the rotating shaft and putting on the ion pumps for monitoring the vacuums at various tank pressures. The RGA reading and IP02-2 pressure, at different tank pressures is tabulated in Table 1.

The observations are plotted in Fig. 1. Vacuum reading of all the ion pumps especially of IP022 (ion pump just above the tank) and RGA reading of SF6 followed a similar pattern. And reading of both started coinciding at atmospheric pressure. This clearly indicated following:

1. The residual gas inside the tube was SF6.
2. The leak developed was not pressure dependent.
2.1 Hunting of leak and sealing it

Leak detection started just after the tank opening with the help of Vacuum Lab. A leak detector was connected to pendulum valve in the 02 area (i.e., sixth floor). The procedure employed was same as conventional leak detection. Accelerator tubes were sprayed with helium starting from the top of the tank. The leak was detected in second tube of unit number eight. To pin point the leak now leak detector had to be connected somewhere near to this spot. So it was connected to the pumping port in area D1. The leak was detected approximately between electrode 6 to 8.

A similar leak once existed in unit #5. It was sealed with a sealant. Also it was working fine since last few years. Keeping this fact in mind this leak was sealed using same sealant. After confirming that this particular leak has been sealed, the leak test was resumed and was carried out up to tank bottom. Several leak tests confirmed that there was no other leak and this particular leak has been sealed.

The tank was closed and after gas handling the procedure of unit-wise conditioning started. Everything went on well till eighth unit was reached.

3 Redevelopment of Leak

During conditioning of unit eight this time, after a major spark vacuum of all the ion pumps above terminal started deteriorating. The guess was that same leak must have redeveloped. After tank opening to ensure that the leak is at the same place, leak checking was carried out using similar procedure and the leak was found at the same place i.e., somewhere between electrodes 6 to 8 in second tube of unit eight. It was decided to replace the tube.

4 Tube Replacement

Tube replacement is tedious job and requires many fore preparations. First thing that was done was venting of the tube above the terminal. The upper manual valve of the terminal was closed and tubes were vented from pendulum valve above the
tank. The equi-potential rings of the units 7, 8, 9 were removed. The tube resistors and column support post resistors were removed.

The jacks were used to maintain the alignment of tube. The space between flange and the first electrode of a tube is right place to fit the jack. So spacers were put between jacks and casting cover, so that jack could reach up to the flange of the tube. Stainless steel rings of 2.5 cm thickness were used as spacers. Using jacks the tubes were held firmly in unit seven and nine. In the ninth unit the jack was necessary because ion pump or other instrument attached to the tube in the dead section 1, which is just below unit nine, were capable of changing the alignment of tube.

The jacks in the seventh unit was to serve two purposes. First to maintain the alignment of tube secondly to lift the tubes above for replacing of the particular tube.

The space between the end electrodes of tube and flange is like a bellow. So using jacks the entire tube structure can be raised to a certain extent.

After fixing the jacks properly all the alignment screws of the accelerator tube were loosened. These alignment screws are fixed between the inner periphery of casting cover and flange of accelerator tube, which lies at that place. Before doing this, for maintaining the earlier alignment after all the procedure, the screws were marked before they were loosened.

The allen bolts connecting second tube of unit #8 loosened. The nuts were removed but for maintaining the alignment the bolts were initially left in the slots. Using the jack on the seventh unit the upper sections of the tube were raised to a sufficient height (approximately 2.5 cm). Carefully bolts were removed, and then the metallic o-ring between tubes was removed. Then the tube was removed. It was inspected and electrodes inside it were found to be all right.

The new tube was then inspected physically. The aperture plate, which exists on the starting of the tube, was taken from the replaced tube and fixed on the new tube. The new tube was placed at the proper position after putting a metallic o-ring. A metallic o-ring was placed on top of the new tube too. The lower part of new tube was bolted with the tube assembly below. Then the upper tube structure was slowly lowered. The upper tube structure was carefully bolted with the new tube. Three rounds of tightening were carried out with the same hands to ensure uniform tightening of the tube. Immediately after that vacuum pumps were started.

Next day, initial leak check was carried out. The alignment screws were tightened. The initial check did not show any leak. The entire new tube and surrounding were baked for more than twenty-four hours. Again entire low energy section was leak checked, with positive result. The resistors were put back in their respective places.

Confirming no-leak situation, the tank was closed. Conditioning started just after the required tank pressure was attained. In the initial conditioning of full column terminal potential reached to 9.45 MV at cps 6.0 kV.

After the initial full column conditioning the conditioning of eighth unit was taken up. The first spark occurred at 0.69 MV, deteriorating the vacuum. Unit eight was conditioned for four days continuously. Terminal potential stabilized at 1.1 MV. Vacuum of area D1 during this period improved from 4.9 to 4.75 torr, whereas vacuum of terminal area T1 practically remained constant at low 10⁻⁵ torr.

After that the machine was conditioned with full column live for 12 days. Initially the machine sparked at 10.34 MV, but with conditioning the terminal potential kept on increasing. Maximum potential attained was 13.8 MV. In between the vacuum of area T1 also improved and reached 8.0⁻⁵ torr on fourth day of conditioning.

5 Conclusion

Oxygen beam was successfully given to user, which was followed by silver beam. Unit-wise conditioning was then carried out for the units 12, 13, 14 and 15 for two days. In the mean time the vacuum of area T1 further improved to low 10⁻⁵ torr.

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