A.5 : HV generator of 750 kV DC accelerator commissioned for rated beam energy:

The upgradation work carried on HV generator by Power Supplies Division during the year 2006-07 has been successful and the DC accelerator is now commissioned for its rated beam energy of 750 kV. Details of the upgradation work can be referred in *RRCAT News Letter, vol. 20, issue 1, 2007*. Major challenges with appropriate solutions regarding upgradation of HV generator were published in above news article. Status of integration of accelerator with HV generator and commissioning phase difficulties along with adopted solutions are being reported here.

After testing the HV generator upto 760 kV in February 2007, the major challenge was to design and develop the filament transformer with primary input voltage of 90 kV peak and operating frequency of 40 kHz. The transformer was realised by splitting it into two units of 45 kV: 22 V each and connecting them in series on high voltage side to operate in centre-tap configuration, thus reducing the insulation requirement to half (Fig.A.5.1). Secondary windings are feeding the load in parallel mode. Total 16 pieces of U&I-100 sections of ferrite cores were clamped together to realise a shell type structure for individual transformers. The centre-tap point of the transformer is connected to the terminal voltage of HV generator (-750 kV) through a 40 MΩ HV resistor, and the input terminals are connected to the oscillating columns of the multiplier stack.

After testing the filament power supply with new filament transformer, the HV generator was integrated with the accelerating column and the accelerator was charged up to 720 kV in June 2007. Next challenge was to protect the high voltage components during arcing in the accelerating column due to poor vacuum, which had led to failure of series of diode stacks in past. Augmentation of the arc protection circuit was taken up in July 2007 and a new mechanism of arc-protection was devised by introducing a surge arresting capacitor between the earth terminal and the common point of the multiplier stack. The new protection scheme is working fine and it is so sensitive that even a small arc of diaphragm electrode could be sensed and supply is promptly tripped. Reliability of the protection circuit has been rigorously tested at full operating voltage of 750 kV.

After executing all these improvements, the commissioning trial of the accelerator started in August 2007 with a beam current of less than 1 mA at 700 kV. For next few months, the machine was operated at low energy with beam current upto 5 mA for vacuum conditioning of the accelerating tube. It was noticed that only one side of the multiplier-stack diodes were conducting and the other side of the stack was resting idle. This was happening because of the mismatch in the peak voltages of the two transformers feeding the multiplier stack. The problem was expected at lower currents which otherwise would have got eliminated once the high current operations were reached. Due to the high frequency operation, this situation may come at sufficiently large currents and operating the machine in this manner at low currents would not have been safe. So, it was decided to take some remedial action in this regard before moving on to further higher voltage and currents.

A simple solution was envisaged and the problem was solved by inserting a small value of water cooled non-inductive resistor in the primary of the transformer, which was generating higher voltage. After this corrective measure, both sides of the multiplier stack started conducting and the diode peak currents was observed to be in safe limit in the entire rage of the beam current. By the end of December 2007, the accelerator had been tested up to 700 kV accelerating voltage and 5 mA of beam current. Further experiments were suspended due to expiry of AERB permission for operating the accelerator. The permission was renewed in March 2008.

The commissioning trials started again in the second quarter of 2008 and after solving several problems of vacuum and spurious tripping of the high voltage generator, the accelerator is now being successfully operated at 750 kV with beam currents of 10 to 12 mA.

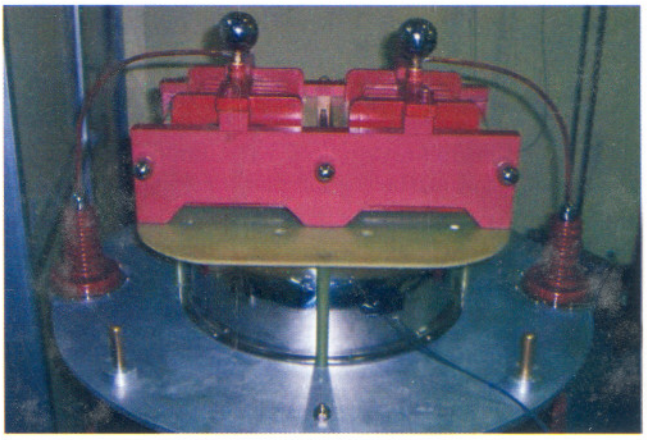

Fig.A.5.1 Filament transformer and injector control unit of 750 kV DC accelerator.

Reported by:
R. Banwari (banwari@rrcat.gov.in) and
Apollo Kasliwal