I.1: Fabrication of 270° bending magnet vacuum chamber for 9.5 MeV, 10 kW linac

A 9.5 MeV, 10 kW linac is being developed for irradiation of medical, agricultural and industrial products. The linac is required to be fitted with a 270° energy filtering system to limit the maximum output energy of electron beam to 9.5 MeV in electron mode and 7.5 MeV in x-ray mode of irradiation. Figure I.1.1 depicts the schematic of the complete 270° energy filtering system. The 270° energy filtering system is mounted on a vacuum chamber of varying sections. The resulting assembly bends the electron beam accurately through an angle of 270°. The vacuum chamber has been designed and fabricated in-house, as an independent unit. Various design and fabrication details of the vacuum chamber are discussed here.

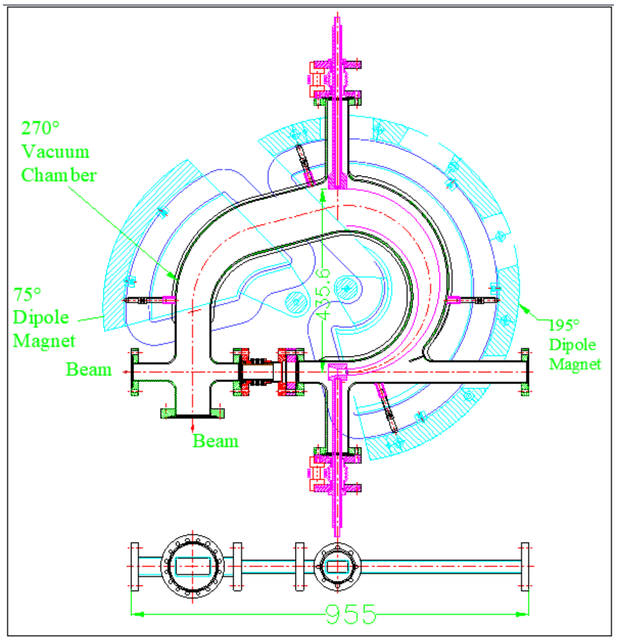

Fig. I.1.1: Schematic diagram of 270° energy filtering system.

Dimensions of the Vacuum Chamber: Height of the vacuum chamber is 26 mm in the bending magnet pole area, and 40 mm at the entry and exit points of the electron beam. Figure I.1.2 is a 3D view of the vacuum chamber.

Material used in the Vacuum Chamber: The vacuum chamber is manufactured from Austenitic Stainless Steel of grade 316L, using 3.0 mm thick sheets.

Technical details related to the fabrication process: Computer numerical control (CNC) water jet cutting machine was used to cut the raw material used for fabricating various components of the vacuum chamber. This helped to avoid excessive heating of the raw material, which poses problems in the form of severe distortion, heat affected zone (HAZ) and impaired magnetic permeability of the components. Manual gas tungsten arc welding (GTAW) process was adopted for the manufacturing of the chamber, since the welding was required to be performed on thin and moderately thick metal sections. Distortions caused during the welding of vacuum chamber were controlled using staggered and sequential welding technique, dedicated fixtures and by use of heat sink plates with matching profiles throughout the entire welding process. Optimum welding current and precisely controlled weld speed also helped in minimizing distortions. Formed cooling channels were welded after the joining of the entire vacuum chamber.

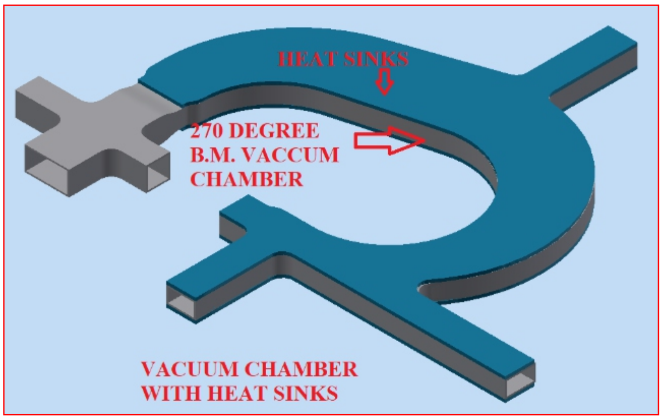

Fig. I.1.2: 3D view of vacuum chamber.

The successful fabrication of the 270° bending magnet vacuum chamber was carried out in-house. Figure I.1.3 is a photograph of the fabricated vacuum chamber. Distortions in the vacuum chamber were effectively controlled to within 1.0 mm over the entire surface area. The vacuum chamber was vacuum leak tested and it performed satisfactorily with a leak rate of 5.0×10^{-10} mbar l/s.

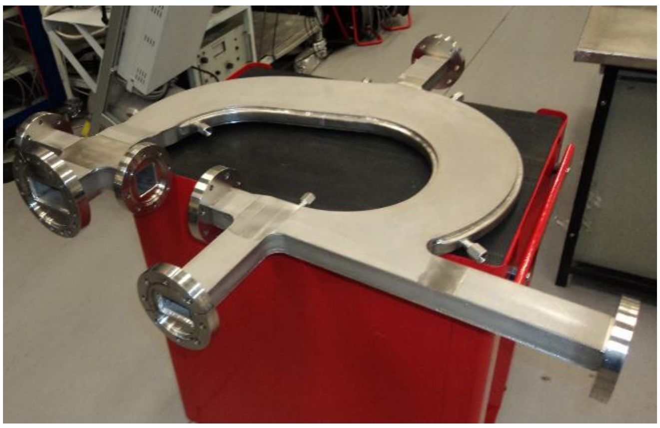

Fig. I.1.3: Photographic image of vacuum chamber for 9.5 MeV linac.

Reported by:
Vivek Bhatnagar (vivek@rrcat.gov.in)