

SF₆ Gas Monitoring and Safety for DC Electron Beam Accelerator at EBC, Kharghar, Navi Mumbai

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The DC electron beam accelerator has been designed for industrial applications to operate in the 1-3 MeV with a beam current of 0-10mA and product coverage range of 1000mm x 50mm. The accelerator tank houses the high voltage multiplier columns, RF electrodes, corona shields, electron gun, accelerating tubes, heat exchanger, RF transformer etc. Normal operating pressure inside the accelerator is 6 kg/cm² of SF₆ gas. It is 7 meters long has a maximum outer diameter of shell is 2.16 meters and volume of 26 m³. The SF₆ gas supply is contained in two storage tanks whose total capacity is 32 m³. The SF₆ gas cooling system of 5 ton capacity has been used for cooling the SF₆ gas inside accelerator tank and transformer vessel.

SF₆ is the most suitable medium for insulation and cooling purpose. It is having an excellent arc quenching properties. SF₆ has chemical stability, good thermal properties and non toxic. SF₆ gas when released into the atmosphere contributes to green house. Its GWP is 23900. It is stable in atmosphere for 3200 years.

Releasing one kg of SF₆ gas in atmosphere is equivalent to waste of 24 tonnes of CO₂ gas.

SF₆ gas handling system

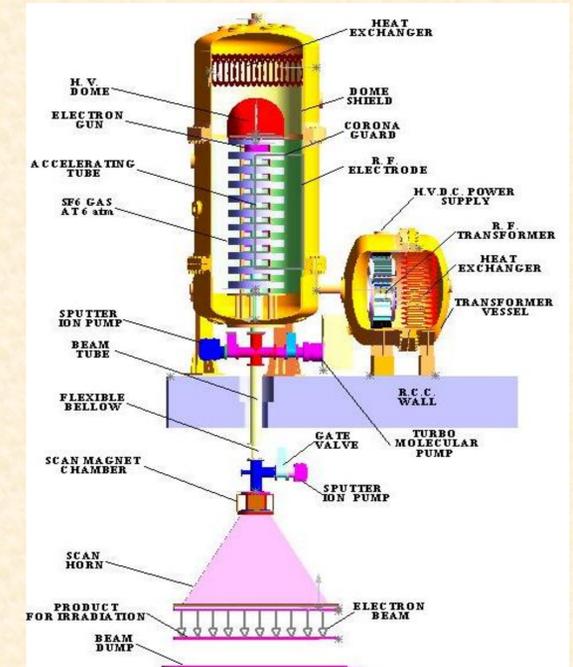
- ❖ Evacuation of Accelerator tank, Storage tanks and associated pipe lines.
- ❖ Transfer of SF₆ gas from SF₆ gas cylinders to SF₆ storage tanks for storage
- ❖ Transfer of SF₆ gas from storage tank to accelerator tank while starting the accelerator
- ❖ Transfer of SF₆ gas from accelerator tank to storage tank for maintenance
- ❖ Recirculation of SF₆ gas during accelerator operation for removal of moisture and secondary products.



300kV, 120kHz RF Transformer



The SF₆ gas Storage Tank



3 MeV, 30 kW DC Electron Beam Accelerator



RF Electrode Assembly

The SF₆ gas management

- Training in SF₆ handling, recycling, reusing, transporting, controlling leakage and minimising SF₆ release.
- The purity, moisture level and SO₂ content should be monitored as per CIGRE B3.02.01 and IEC standards. The moisture affects the electrical insulation. SF₆ decomposition products combine with water to form hydrofluoric acid (HF) and sulphuric acid (SO₂). The purity should be more than 97%, the moisture should be >-36° C and SO₂ should be less than 50 ppm.
- The maximum permissible leakage of 0.5% per year should be allowed as per IEC standard. Area monitoring systems with 0-2000 ppm range based on infrared absorption spectroscopy have been installed at the various locations of the accelerator and gas storage rooms. Portable leak detectors with 0-50 ppm range based on infrared absorption spectroscopy has been used for detecting the leak tightness.
- In order to avoid the contamination of the atmosphere, recycling of the SF₆ is essential. The gas quality has been monitored for purity, moisture and acid after recycling the gas through moisture removal system.

Provision for safe working with SF₆ gas

- ❖ Prepared Handling procedures and instructions.
- ❖ Risks and warning signs are provided.
- ❖ SF₆ gas if released into the atmosphere, tend to accumulate in low-laying areas where there is no natural ventilation and may cause asphyxiation. Individual breathing such an atmosphere may experience symptoms which include headaches, ringing in ears, dizziness, drowsiness, unconscious, nausea, vomiting and depression of all the senses. The skin of a victim of overexposure may have a blue colour. SF₆ gas monitors are provided at proper location and sensor kept at low level.
- ❖ Personal protective equipments like hand gloves, breathing apparatus and goggles are used.

Accelerator operation and testing:

The accelerator has been operated up-to 10 kW. The experiments have been done for simulated flue gas experiment at 5kW power for SO₂ and NO₂ reduction and demonstrated.

Conclusion:

SF₆ gas use has been increased due to increased use in high Voltage power supply, electrical switch gear and accelerators. The Kyoto protocol has strongly recommended the elimination of use of SF₆ gas. The SF₆ gas alternatives will be future of insulation in accelerators systems.