CAT NEWSLETTER

ACCELERATOR PROGRAM

A.1 750kV DC accelerator for industrial applications

A direct current accelerator for industrial applications is designed and developed at Centre for Advanced Technology, Indore. The specifications of the accelerator are below:

Operating voltage range	:	300 – 750kV
Max. beam current	:	25 mA @ 750kV
Beam scanning width	:	50– 120cm
Scanning frequency	:	100Hz

Effective penetration in unit density material (double sided irradiation) : 4mm

Electron gun: Modified pierce geometry current control with bias supply

Accelerating column	:	Titanium electrodes diffusion bonded with high alumina ceramic
HV scheme	:	15 stage, SF6 gas insulated balanced Cockroft- Walton multiplier with driver frequency of 40 kHz

The electron gun, acceleration column, focusing coil, high voltage multiplier stack, filament power supply and the control unit are housed in a 1.5 m diameter and 3.2 m high, pressure vessel. Fig. A.1.1 shows the inside view of the accelerator. Using a 50-micrometer thick titanium foil, the electron beam is extracted in air. A conveyor system is installed to convey items kept in trays, paper pulp sheets, and laminates for curing applications, automatically under the beam.

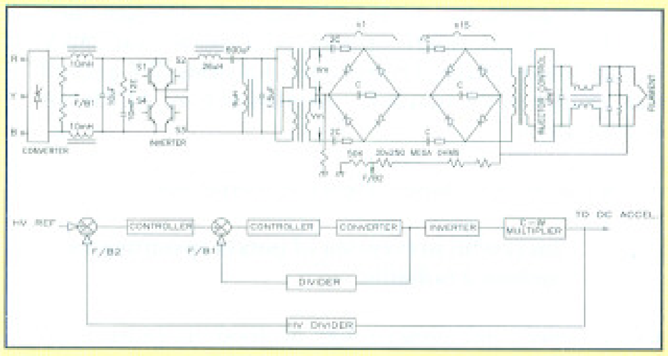

Fig A.1.3 Block diagram and control loop of the HV generator.

The power supply is designed for an operating range of -300kV to -750kV with a maximum beam power of 20kW at -750kV. For generation of accelerating voltage, series fed symmetrical cascade generator is chosen. The advantages of such a cascaded generator are: low voltage ratings of required components, gradual build-up of voltage and modular construction, providing ease in assembly. The use of a high frequency source gives added advantage of low stored energy, less ripple, better regulation and faster response. The availability of power for the filament of electron gun across the oscillating columns is a positive feature of these generators, where a dc isolation of required value is inherently obtained.

The system pressurized with nitrogen gas is installed in the shielded area in Medical and Industrial Accelerator Building, and is operating at 2.5 kW power level as permitted by Atomic Energy Regulatory Board. It is in regular operation since November 26, 2002 for R&D in the field of radiation processing e.g. surface irradiation of fruits and vegetables, curing of coatings, heat shrinkable foils, paper pulp irradiation, irradiation of PMMA films, surface treatment of seeds, cross linking of small cables and wire etc. Fig A.1.2 shows the surface irradiation of potatoes using the system. The block diagram of the power supply

Fig A.1.1 DC Accelerator

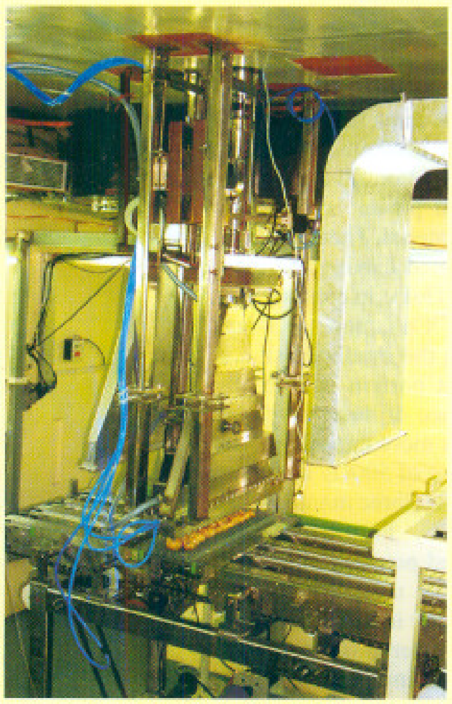

Fig A.1.2 Irradiation of Potatoes with DC Accelerator and its control loop is shown in fig. A.1.3. The high voltage generator is currently operating at a frequency of 5kHz for low current testing of the accelerator during commissioning stage. An emission current of 5mA is drawn at 500kV. All its control electronics and floating power supplies have been perfected during the commissioning stage. The generator will be switched to 40kHz operations for operation at 750kV at high power. The high power operation using SF6 gas will start shortly as the necessary permission from AERB has been obtained.

(Reported by: S.C. Bapna; bapna@cat.ernet.in)

A.2 Successful prevention of potato sprouting by surface irradiation

Conservation and preservation of food in India is as important as production. Losses of potatoes during storage due to disease, softening of tubers, sprouting and frost damage frequently exceeds 25% of the produce. Bhabha Atomic Research Centre, Trombay has been carrying out extensive research on food irradiation using radionuclide sources. A cobalt source based irradiator POTON is being setup near Nasik having an installed capacity of 10 Tones per hour for onions and potato. The irradiation using Gamma rays involves full penetration. The potato has many layers, outer one is called periderm which is neither starchy nor contains any proteins. The next layer, cortex series, is a storage area for proteins and some starches. The third layer called vacular ring receives starch from the leaves and stem. The central portion is the main storage area of starch and is called pith. An experiment was planned to irradiate only surface of the potatoes, so that the main portion pith remains unaffected by the irradiation and at the same time sprouting is prevented. The potatoes have been irradiated at various dose levels using 750kV DC accelerator. The effective penetration of electron beam in the potato is very less (~ 0.7mm) at 480kV in unit density material. Therefore only outer layers of the potato are irradiated leaving the main portion unaffected by electron beam. This is in contrast with the irradiation by gamma rays from ^{60}Co isotope or x-rays from high-energy electron beam. As the irradiated skin is only less than a millimeter and that portion is normally pealed off before using it, acceptance of such irradiated potato for consuming, as food seems more appealing. The potatoes irradiated with a surface dose of 500Gy and more have not shown any sprouting even after three months when kept at controlled temperature of 20°C. Fig. A.2.1 below shows the irradiated and un-irradiated potatoes after three months. Successful surface irradiation using low energy electron accelerator is a major milestone in food irradiation technology, as it will keep the bulk material unaffected by the irradiation and appears more appealing as compared to irradiation by gamma rays.

Fig. A.2.1 Normal and irradiated potato

(Reported by: S.C.Bapna ; bapna@cat.ernet.in)

A.3 Vacuum testing of Indus-2 dipole chambers

The 2.5GeV synchrotron light source, Indus-2, has a circumference of 172.47m and consists of 16 dipole chambers, 8 long straight sections and 8 short straight sections thus forming 8 unit cells.

All the 20 vacuum chambers, including 3 for taking the beam out from insertion devices, have been leak tested. Baking was conducted on 8 chambers and an ultimate vacuum of 10^{-10} torr had been achieved in these chambers. For baking purpose, copper tubes are embedded in the grooves provided on the surface of the chambers and a silicone based compound that is thermally conductive is used to efficiently transfer heat.

Transition joints were made between stainless steel and aluminum tubes by friction welding and is being used to connect the pumps with the extruded straight chambers. These transition pieces were checked for ultimate vacuum and 5×10^{-10} torr vacuum was achieved.

Fig. A.3.1 Assembly for baking of vacuum chambers

(Reported by: R. Shridhar ; srisri@cat.ernet.in)