UTILIZATION OF 10 MEV LINAC FACILITY FOR INDUSTRIAL APPLICATIONS AND RESEARCH EXPERIMENTS

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Abstract

The 10 MeV Linac irradiation facility at EBC Kharghar, BARC is being utilized for different industrial applications and research experiments. On industrial front we have recently irradiated polyethylene gaskets up to two-inch diameter, received from Technocraft Industries India Limited Mumbai, by imparting around 360 kGy. The gaskets were kept on a trolley moving with a speed of 200 mm per minute. Gaskets without irradiation start softening, when heated in an oven for ten minutes at 80 degree centigrade of oven temperature. The gasket irradiated at our facility did not soften in the oven, even when heated in the oven for twenty minutes at oven temperature of 270 ^{0}C. The nearly five times increase in temperature difference between softening point and ambient temperature of gaskets is a commendable achievement and opens the flood gate for irradiation application of gaskets used in the industry. The exotic colour has been imparted in the quartz and gems which can increase their sale value four to five times in general. We have irradiated the plastic materials of different sizes and thickness, received from L & T Limited, Mumbai. The test results are being awaited. We have irradiated rice husks at our facility to standardize the 25 kGy dose for medical products in the moving trolley mode at a speed of 100 mm per minute. Various research experiments of BARC and other universities have been carried out to study the effects of irradiation on materials. This paper describes about the "Utilization of 10 MeV Linac facility for different industrial applications and research experiments" carried out at EBC Kharghar.

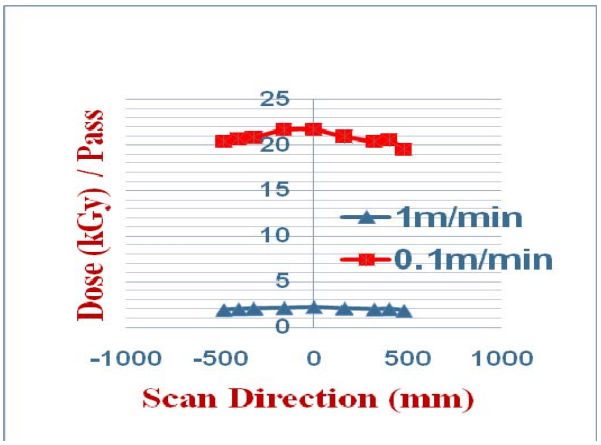
THE 10 MEV IRRADIATION FACILITY

The 10 MeV Linac Irradiation facility consists of the RF Linac and conveyor system. It is housed in a two-storied building with 2.5 meters thick concrete shielding walls. The Linac structure with electron gun, RF cavity, gate valves, SIPs, and beam transport line is at first floor, whereas scan magnet, scan horn, titanium foil, SIP for scan horn and conveyor systems for material handling is at ground floor as shown in figure-1. The Electron beam at 50 keV is generated in electron gun with LaB_6 cathode and is injected into the on-axis coupled cavity linac which accelerates the electrons to energy of maximum 10 MeV. A 2856 MHz, 6 MW Klystron based RF Power source is used to establish the required electric field of 18 MV/m inside the linac. After acceleration, the magnetic sweep scanner deflects the beam in the scan horn and taken out in the atmosphere through a 100 cm X 7 cm, 50 µm thick titanium foil window for radiation processing applications. The complete linac up to titanium foil is maintained in vacuum of 10^{-7} torr with the help of rotary-backed turbo molecular pump and sputter-ion pumps.

Figure 1: Linac Irradiation facility showing electron gun, RF Cavity at first floor and horn, conveyor etc. at ground floor.

CHARACTERIZATION OF THE RADIATION DOSE AT 03 KW BEAM POWER

To achieve the required property changes in the products after irradiation, the limits on the absorbed doses are prescribed. The radiation field of the electron beam produced by the Linac at the conveyor level should be capable of delivering the dose within these prescribed limits. Before product irradiation full characterization of the radiation field was done at RPAD, BARC by measuring the various dose profiles at beam energy of 10 MeV, 03 kW beam power with radio chromic films.



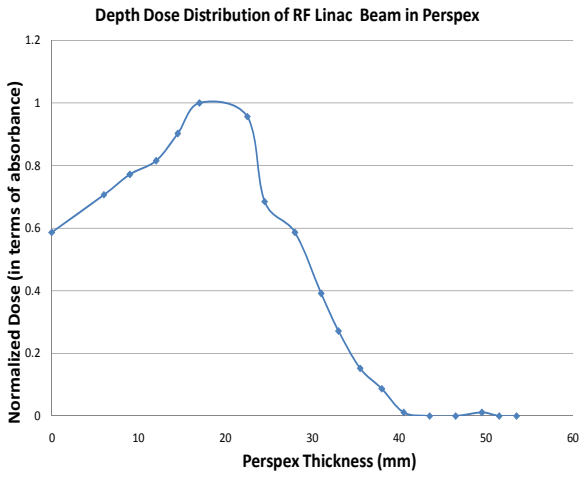


Figure 2: Dose Profile RF Linac and Depth Dose Distribution at 03 KW Beam Power and Scan Freq = 01 Hz.

THE IRRADIATION EXPERIMENTS

Irradiation of Polyethylene Gaskets

We have recently irradiated polyethylene gaskets of two-inch diameter, received from Technocraft Industries India Limited Mumbai, by imparting around 360 kGy. The gaskets were kept on a trolley moving with a speed of 100 mm per minute. Gaskets without irradiation start softening, when heated in an oven for ten minutes at 80 degree centigrade of oven temperature. The gaskets irradiated at our facility did not soften in the oven, even when heated in the oven for twenty minutes at oven temperature of 270 ^{0}C. The nearly five times increase in temperature difference between softening point and ambient temperature of gaskets is a commendable achievement and opens the flood gate for irradiation application of gaskets used in the industry. We have irradiated up to fifty thousand gaskets in eight hours using to and fro conveyor system at 03 kW beam power.

Irradiation of Food Products

A food irradiation experiment was carried out collectively by EBC and FTD (Food Technology Division) of BARC in electron beam mode at 10 MeV beam energy and 750W of average beam power with conveyor speed of 02m/min. The required dose range asked by FTD was 400 – 1000Gy for the irradiation of potato. Sample size for potato irradiation was 340 mm in conveyor movement direction (say Y-axis), 250 mm in the beam scan direction (say X-axis) and 90 mm in the beam travelling direction (say - Z axis).The weight of the sample in a single box was approximately 4.5 kg. The absorbed dose at nine different locations, by placing three radio chromic films at three layers namely top, middle and bottom; in the box was measured at RPAD, BARC. The absorbed dose at nine different locations in the box is in the range of 410Gy to 540Gy, which are within the range.

Irradiation of Paddy Husk to Characterize Sterilization of Medical Products

An experiment was carried out by using paddy husk for simulating the medical products for dose distribution required for the sterilization of medical product. Minimum dose delivered was 30kGy and dose uniformity ratio (DUR) is about 2 while the recommended threshold dose is 25kGy and DUR is 1.5 to 3. [2]. We have also carried out some beam trials on IVS and irradiated syringes has been sent to lab for actual sterility test. The box size used for this experiment was 340 mm length in the beam scan direction, 530 mm width in the conveyor movement direction and 430 mm depth in the beam movement vertical direction.

Exotic Colour Changes in Gems

We have also produced exotic colour changes in white gems by irradiating it with electron beam.

CONCLUSION

The dose profile is uniform with ±5% variation which is allowed as per international standard. The output beam energy is experimentally verified and that is 10MeV. The system is being used for gasket irradiation on commercial

basis and ready for the sterilization of medical products on commercial scale.

REFERENCES

[1] “Present Status of 10 MeV, 10 kW Industrial RF Electron Linac”, R.C. Sethi et. El., InPac-2005, VEC Calcutta

[2] IAEA Trends in Radiation sterilization of Health Care Products -2008”