INFO SHEET
Department of Atomic Energy

Electron Beam Accelerators for Material Processing

Charged particle accelerators have been playing a key role in the field of basic and applied sciences. Material processing is one of the applied areas which has been greatly influenced by these accelerators. The major credit for this goes to electron beams. Beams varying in energy from a few hundred keV to a ten of MeV, and powers from a few hundred watts to a few hundred kW, have been extensively employed for this purpose.

Electron beams with an energy of 0.5 MeV and power of 10 kW are used for curing of coatings, adhesives and paints. The heat shrink materials employ electrons in the range of 0.3 MeV to 2 MeV. To improve the lubrication property, Teflon is treated with 2 MeV and 10 kW beam. Diamonds with exotic colors are produced by using electrons up to 7 MeV. Green strength of rubber is enhanced by exposing it to a beam of electrons of 2 MeV & 30 kW. Beams up to 10 MeV are being routinely used for cross linking of cables, food preservation, medical sterilization, viscous Rayon processing etc. Even the pathogenic germs of the sewage and sludge are taken care of by electron beams having energy of 1MeV and power of 100 kW. The field is growing at a fast pace.

BARC made a beginning in this direction more than a decade back. A Russian built machine, ILU6, having energy as 2 MeV and power of 20 kW was purchased for developing electron beam based processes. The accelerator is located at Vashi, Navi Mumbai. By using this machine, quite a few processes including cross linking of cables, irradiation of diamonds, degradation of Teflon, treatment of heat shrinkable materials etc., were developed. The Indian industry started realizing advantages and enormous potential of this technology over the conventional techniques. In view of the large demand of such machines, a highly pragmatic approach of developing an indigenous base in the country was initiated by DAE.

Indigenous development started at Trombay around 1995. To cover the diverse needs, three energy regimes were thought to suffice. The low energy 500 keV, 10 kW, DC Accelerator for catering to the surface modification processes. The medium energy 3 MeV, 30 kW, DC Accelerator for taking care of the bulk load of cross linking and heat shrink materials. The high energy 10 MeV, 10 kW, RF Linac for meeting the large penetration depths required in food processing, diamonds etc..

Trial assembly of 10 MeV, 10 kW RF Electron Linac

The 500 keV accelerator was made operational in the year 2000. This accelerator, installed at Vashi, Navi Mumbai, is in regular use for surface modification applications. Since this was the first venture taken up by BARC, several technical problems were encountered. These have since been solved and system has been perfected.

The accelerator delivers 5 kW beam at an energy of 450 keV, routinely. The stability in beam energy and current is within ± 1 % and ± 3.5 % respectively, same as available from any commercial machine.

3 MeV, 30 kW accelerator is in advanced stage of completion. Here also quite a few technological challenges are being met by BARC.

Since, these jobs are being addressed for the first time in the country and do not fall in the routine line of manufacture, the Indian industry had to be slowly educated and persuaded to take up such challenges.

10 MeV, 10 kW RF Linac development, is one of the most challenging tasks, taken up by BARC. The design of the linac has been conceived for a RF frequency of 2856 MHz The heart of the accelerator is the RF cavity, fed by a microwave power source having peak power as 6 MW and average 24 kW. To maintain the proper RF properties, the overall dimensional tolerances of the acceleration cavity have to lie within 20 - 30 μ. The challenge of building the microwave source has been taken up by SAMEER, Mumbai. Most of the subsystems of the 10 MeV Linac are ready.

Electron Beam Centre (EBC), Kharghar, Navi Mumbai

An Electron Beam Centre, totally dedicated to the cause of research and development in the area of electron beam accelerators and their applications in the industry, is being set up at Kharghar, Navi Mumbai. The Centre will house both, 3 MeV & 10 MeV accelerators. It is planned as a self sustained centre, equipped with all types of labs needed for carrying out modifications and improvements in the future. The EBC building is ready, labs have been equipped with the respective instruments and all the general purpose utilities are functional.

Electron Beam Centre for Material processing, Kharghar, Navi Mumbai

Similar indigenous efforts are also being made at the Centre for Advanced Technology (CAT), Indore, Madhya Pradesh. Here, a 750 keV DC accelerator built by them and is now undergoing commissioning trials. This Centre has also built a 12 MeV microtron, being already used for material processing. In addition, CAT is putting efforts to develop a 10 MeV Linac and a 2-3 MeV DC machine, in collaboration with Russia.

The private enterprise of the country by now has understood the usefulness of this technology. M/s. Nicco Corporation Ltd., Kolkata, an electrical cable manufacturing company, have learnt and acquired the techniques of radiation processing from BARC, before purchasing a machine of 3 MeV, 150 kW. Another plant with an energy of 3 MeV and power of 50 kW has been set up at Hyderabad by M/s Radiant Pvt. Cables Ltd..

A unique venture like electron beam processing for industrial processing, has come to stay in this country. The efforts initiated by DAE are thus finally becoming fruitful in establishing a good base in electron beam technology and materials processing.

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