

Application of Electron Accelerators: Prospects and Challenges

A.J. Berejka

Ionicorp, Huntington, New York, USA

Abstract. Electron beam (EB) accelerators are used in diverse industries to enhance the physical and chemical properties of materials and to reduce undesirable contaminants, such as pathogens or toxic by-products. Electron beam accelerators are reliable and durable equipments that produce ionizing radiation without relying upon radioactive isotopes. EB equipment can be turned on and off as any other industrial electrical equipment. These electron accelerators can be used as tools in basic and applied research, but also in pilot plants for demonstration of the feasibility of a certain radiation processing technology, as well as in industrial-scale facilities. Different end-use areas need accelerators with different energies as well as different under-beam handling systems.

1. Introduction

The Electron Beam (EB) Satellite Meeting (AccApp '09) consisted of six sessions during which twenty-four oral presentations were made. These were complemented by poster presentations as well. A separate session was held to review the IAEA working material on "Industrial Electron Beam Processing" that was made available to attendees on CD (Anthony Berejka and Marshall Cleland, USA). In addition, two panel discussions were held:

1. Radiation processing for enhancing development of less developed countries and for sustainable development.
2. Challenges for expanding the use of EB accelerators in industrial applications and the role of the IAEA in promoting EB processing.

Presentations were also made in the Accelerator Applications sessions that were of interest to the industrial community.

2. Summaries of sessions

In the first session, three presentations were made that described the markets and uses of industrial EB accelerators on a world-wide basis and outlined some of the changes in the market and evolving areas of opportunity. Anthony Berejka (USA) gave a world-wide overview and pointed to the down-sizing of low-energy EB equipment and to the emergence of industrial X-ray processing. The industrial use of accelerators in South and Central America and opportunities were described by Wilson Calvo (Brazil). An analysis of the uses of EB processing in Japan and a description of new applications, such as PET bottle decontamination, were described by Sueo Machi (Japan).

A.J. Berejka

Food irradiation and the use of EB for sterilization and surface decontamination were discussed in a second session. Anna Lucia Villavicencio (Brazil) discussed the prevention of color changes in irradiated cabbage. She also gave a presentation on advances being made in Brazil on the use of irradiation for food preservation. Nelida del Mastro (Brazil) presented results showing the influence of irradiation on the food contents when irradiated in a package, when by-products such as ozone can become trapped. Didier Morisseau (France) discussed the new application of using EB surface treatment to decontaminate packaging materials before entering aseptic packaging equipment. This represents a major new end-use of low-energy EB equipment. Zbigniew Zimek (Poland) described equipment and systems developments in Poland for medical device sterilization.

The effects of irradiation on polymeric materials were covered in the third session. Olgun Gueven (Turkey) described some innovative uses of EB grafting to enhance material properties. Anna Lucia Villavicencio (Brazil) showed that low dose irradiation (1 to 2 kGy) had little effect on the texture or color of natural palm while still preserving it. Giuseppe Spadaro (Italy) showed how thermal effects, either during EB curing or post-curing treatment, affected the properties of the matrices of fiber reinforced composites. Susy Sabato (Brazil) presented results on how irradiation affected the viscosities of liquid sugars. Esperidiana Moura (Brazil) described the irradiation effects on ethylene-vinyl alcohol (EVOH) including the results of thermal analyses and studies of morphology using scanning electron microscopy (SEM).

The fourth EB satellite meeting session continued discussions of EB effects that are of industrial interest. Marco Lavallo (Italy) presented how a compact device can be used to monitor the output for EB equipment. Ana Mastral (Spain) discussed how EB treatment can be used to eliminate polyaromatic hydrocarbons from emissions. Abbas Behjat (Iran) showed how scavengers could be used to eliminate heavy metals from EB treated wastewater. Nikolay Dutskinov (Bulgaria) described a new flue gas treatment facility that is under consideration in Bulgaria.

Three presentations on environmental applications were made in the fifth EB satellite meeting session. Bumsoo Han (Korea) presented two papers: one dealing with the cost analyses for EB treatment of wastewater treatment and the other on the use of EB for sewage sludge treatment on a large scale basis. Jinkyoo Kim (Korea) gave more detail on the accelerator system to be used in the Bulgarian flue gas treatment project.

The sixth EB satellite meeting session dealt with diverse topics. Josef Mittendorfer (Austria) described the use of Monte Carlo modeling to illustrate the performance of EB and X-ray process lines. Chuanxiang Tang (China) described the development of a cargo inspection system based on EB. Anne Testoni (USA) was unable to be present but her paper was given by Anthony Berejka. This discussed the development of low cost, modular EB equipment. Nikolay Kuksanov (Russia) described the work on high power accelerators going on at the Budker Institute.

3. Other presentations

In the Accelerator Applications sessions, three papers of notable interest to the industrial EB community were:

- Ahmed Basfar (Saudi Arabia) on flue gas treatment.
- Marshall Cleland (USA) on radiation curing of carbon fiber composites.
- Robert Hamm (USA) on an industrial review that includes ion beam equipment.

4. Panel discussions

The panel discussion at the end of the EB satellite meeting included comments by Wilson Calvo (Brazil), Sueo Machi (Japan), Andrzej Chmielewski (Poland), Olgun Gueven (Turkey), and Marshall Cleland (USA) as well as remarks from the attendees. Some added input for inclusion in the document on “Industrial Electron Beam Processing” was to be forwarded by some attendees. In conclusion, the EB satellite sessions observed that:

- Non-technical market barriers inhibit the growth of proven EB technologies such as:

Food Irradiation

Environmental Remediation

- Cost-effective, low energy equipment has been integrated into systems that decontaminate the surfaces of packaging materials to be used in aseptic packaging.
- End-use applications involving low-energy EB equipment is the fastest growing market segment.
- Very powerful, 300 kW to 700 kW, EB accelerators have made X-ray processing a commercially viable alternative to the use of isotopes.