Industrial EB Processing Accelerates

By Anthony J. Berejka

Over the past year, several conferences focused on the uses of electron beam (EB) processing, including:

- The American Nuclear Society and International Atomic Energy Agency (IAEA) co-sponsored the 9th International Topical Meeting on Nuclear Research Applications and Utilization of Accelerators (AccApp 09), held May 4-8 at the IAEA headquarters in Vienna, Austria, during which there was an EB satellite meeting.
- The U.S. Department of Energy (DOE) Office of Basic Energy Sciences-supported meeting on "Radiation Chemistry in the 21st Century—A Visionary Meeting" was organized by the Notre Dame Radiation Laboratory (NDRL) and held July 12-15 at the University of Notre Dame, in South Bend, Ind.
- The U.S. Department of Energy-sponsored symposium on "Accelerators for America's Future," held October 26-28 in Washington, D.C., which had an industry working group.

AccApp 09

There were 240 radiation scientists from numerous IAEA member states who participated in the weeklong 9th International Topical Meeting on Nuclear Research Applications and Utilization of Accelerators. The EB Satellite Meeting (SM/EB), which was being organized in 2008 (see the *RadTech Report*, September/October 2008 "IAEA Consultants Endorse Use of Low-Energy EB Processing"), covered the "Applications of Electron Accelerators: Prospects and Challenges." The SM/EB sessions had approximately 50 participants, 31 presentations and two panel discussions from representatives of 14 IAEA member states. In addition to the open panel discussions, two presentations were of special note:

1. Didier Morisseau, from Getinge Linac Technologies in France, described the opening of a new market for low-energy EB equipment for the surface decontamination of materials before they enter an aseptic filling line. Getinge Linac had installed or was in the process of constructing 19 lines of its SterStar™ system, each using three low-energy EB units for the surface decontamination of packages for the aseptic packaging of pharmaceuticals. At least another eight lines of two EB units each are being used in the aseptic packaging of food products. This use of low-energy EB eliminates the need for terminal product radiation sterilization that has historically been carried out using gamma rays from radioactive cobalt-60 sources.
2. Marshall Cleland, co-founder of Radiation Dynamics, Inc. (now IBA Industrial, Inc.), and I reviewed our document on "Industrial Electron Beam Processing," covering accelerator technology with equipment from 14 vendors; the effects on materials; and major and developing end-use applications.

This working material, now in publication at the IAEA, is an introduction to EB processing and a detailed history of the technology's development. It contains 14 tables, 116 figures and relied upon 294 references for its 84 pages of text. For more information, contact *berejka@msn.com*.

The AccApp 09 Electron Beam Satellite Meeting covered all industrial uses of EB technology. It concluded that:

- Non-technical market barriers inhibit the growth of proven EB technologies such as food irradiation and 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 are the fastest growing market segment.
- Very powerful, 300 kW to 700 kW, high-energy EB accelerators have made X-ray processing a commercially viable alternative to the use of radioactive isotopes.

Radiation Chemistry in the 21st Century

There were 96 participants at this two-and-a-half day meeting on radiation chemistry. Most of the attendees came from either academic institutions or government laboratories. There were 26 scientific papers presented and 50 posters with participants from nine foreign countries. In addition to outlining the current status of the field, this visionary meeting charted future directions for radiation chemistry in numerous areas, including instrumentation, nuclear power, polymers and biochemical applications. Of particular note were three papers:

1. David Bartels, from the NDRL, gave a presentation on the "Radiation-Induced Reactions in Water at High Temperature and Pressure" which dealt with the fundamental aspects of what happens in water in cooling loops of conventional nuclear reactors. Understanding the kinetics of these reactions is fundamental to anticipating the longevity of containment vessels. Nuclear power has only been around for a few decades (only since the late 1950s). As a source for electrical power, nuclear energy represents the greatest potential energy that has no carbon footprint or toxic or greenhouse gas emissions.
2. Thomas Orlando, from the Georgia Institute of Technology, showed how low a level of ionizing radiation is needed to generate double strand breaks in hydrated DNA (as it exists in life forms). An implication of this fundamental research is that we are probably over-exposing people in medical procedures and certainly over-exposing materials when sterilizing or decontaminating materials for medical devices or in the food area.
3. Jay LaVerne, also from the NDRL, described how radiation can more readily decompose simple aromatic structures usually considered radiation-resistant if such aromatics had some pendant side chains. These insights are useful in understanding how best to use ionizing radiation in remediation processes.

Accelerators for America's Future

Approximately 400 radiation scientists convened for the DOE symposium on "Accelerators for America's Future," held October 26-28 at the Wyndham City Center Hotel in Washington, D.C. The first day of the symposium was devoted to eight plenary session papers ranging from astrophysics to uses of accelerators in medicine and for national security applications. Most of the attendees were either from DOE national laboratories or from universities doing DOE-supported research. On the second and third days of the symposium, invited attendees assembled in five working groups, including (1) Discovery Science, (2) Medicine and Biology, (3) Industrial Applications and Production, (4) Energy and Environment and (5) National Security.

The industry working group was co-chaired by Marshall Cleland (IBA Industrial) and Kathleen Amm (General Electric Company). Of the 20 participants in this group, 10 had actual experience with industrial accelerators. The three U.S.-based, low-energy EB suppliers were all represented, including Sam Nablo (founder of Energy Sciences, Inc.), Terry Thompson (owner of PCT Technologies) and Anne Testoni (Advanced Electron Beams). In addition to Marsh Cleland, two other industrial accelerator manufacturers were part of this group—Peter Wasik, Jr. (Wasik Associates) and Greg Norton (NEC, a supplier of positive ion equipment).

The major end-user of EB processing, the Cryovac division of the Sealed Air Corporation (which has by far more industrial accelerators in use than any other company), was represented by Hans Weigert. Ken Koziol, who had operated a toll processing EB facility for IBA and then for Sterigenics; Bruce Miller, Ktech Corporation, who personally is experienced in food irradiation; and I were also members of this industry group.

Because of their inappropriate fit in this symposium's Energy and Environment working group, a joint session was held in which Andrzej Chmielewski (Institute of Nuclear Chemistry and Technology, Warsaw, Poland) and Bill Cooper (University of

California, Irvine) gave presentations on their areas of expertise. Chmielewski covered the use of EB to eliminate acid rain-forming emissions from fossil fuel-fired powered plants, including a description of the full-scale operation at a power plant in Pomorzany, Poland. Cooper discussed the use of EB for water treatment. In addition to being able to disinfect sewage sludge and remove toxic halocarbons from drinking water, Cooper pointed to a new concern in public drinking water systems—the drugs and drug byproducts that are passed as waste from human use and are not removed by conventional water purification methods. EB treatment may be the only way to decompose these substances.

The industry working group made several key findings and suggestions for DOE involvement:

- Industry has responded to market demands with a broad array of accelerator technology. There is no need for DOE intervention in equipment technology itself.
- Industry could use greater federal support and incentives to expand market awareness of the societal benefits of EB processing, such as the elimination of volatile organic compounds in printing and coating operations; and the greater energy efficiency in crosslinking polymers into value-added commercial products and in other areas of proven commercial success. Assistance in the academic training of professionals in the radiation processing field is also needed.
- As an example, one small segment of the low-energy EB market on which there is some defined market statistics (coil coating) could, if entirely converted to EB processing in the U.S., result in a reduction of electrical power demand equivalent to the output of a moderately sized generating plant. When compared to more historic processes, such as the industrial use of heat from ovens, EB results in the greatest energy conservation.
- For large-scale operations (such as the treatment of stack gases from fossil fuel-fired power plants and as the treatment of water and waste water systems), DOE funding is needed to construct full-scale demonstration facilities here in the U.S. The engineering community will not be convinced of the proven merits of EB in these areas without the large-scale demonstration of EB effectiveness and reliability.
- Federal laboratories and agencies should respect intellectual property rights when interacting with industry. Technical developments made using any taxpayer funding should be made available to the public-at-large at no cost. For example, in Europe one can freely obtain Monte Carlo codes for process simulations from national or European entities, whereas in the U.S. royalty payments must be made to national laboratories even though such codes were already developed at public expense. ◗

Conference Web sites

AccApp 09 Proceedings

http://www-pub.iaea.org/MTCD/publications/PDF/P1433_CD/datasets/foreword.html

Radiation Chemistry in the 21st Century

http://www.rad.nd.edu/ and www.rad.nd.edu/Program.pdf

Accelerators for America's Future

www.acceleratorsamerica.org

www.acceleratorsamerica.org/symposium/agenda.html

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