FNCA2009 Electron Accelerator Application Workshop

- Radiation Processing of Natural Polymers –

Summary of the Presentations at the Open Seminar on the Perspective of Radiation Processing Applications

A. Presentations

1. Global Status of Industrial Applications of Radiation Processing by Dr. Sueo Machi (FNCA Coordinator, Japan)

It was first emphasized that radiation/isotopes are used for sustainable development and poverty reduction. The points are highlighted were (1) Worldwide there are 1400 units high power EB for commercial use for production of advanced products and 250 units of EB are used in Japan; (2) Advantages of Radiation processing which can perform at room temperature without catalyst (pure product); (3) Processing in solid state molded product (Pipes, tubes, wires, sheets); (4) Application for polymeric advanced materials are heat resistant wires/ cables/pipes, heat shrinkable tubes/sheets, automobile tires, formed PE, buttery separators (5) Surface coating by low energy EB is energy saving and environmentally friendly, and has better surface hardness; (6) EB technology for cleaning flue gases from power plant by removing SO_2 and NO_x are used in industrial scale in Poland and China and planned to be used in Saudi Arabia and Bulgaria; (7) Cleaning waste water from dying factory by EB is used in industrial scale in Korea.

The conclusions include the following:

-Industrial application of radiation processing will further grow in modification of polymeric materials

-Radiation technology for clean environment should be further developed to address world common problems

-Development of reliable and less expensive electron accelerators with large capacity is an important challenge

2. Recent Promising Research Outcome on Radiation Processing in Japan by Dr. Masao Tamada (Japan Atomic Energy Agency)

Many products such as heat-resisting, polyethylene foam, and separator in button-shaped battery were commercialized using radiation processing of polymer in 20 century. Then, wound dressing and bedsore prevention mat were developed as the result of technical transfer of the radiation processing technology to private companies. Radiation processing of polymers is a sophisticated tool for the modification of polymers. The graft polymerization can impart the desired functions to trunk polymers. The crosslinking can improve the polymer properties of thermal resistance, mechanical strength, and solubility. In the case of grafting, it was found that grafting was highly effective in emulsion system. Emulsion system is composed of monomer dispersion in water phase. This environmental-friendly practical grafting has been applied to the production of filter for ultra-pure water. This grafting realized the chemically triggered biodegradable material. Biodegradability was induced by hydrolysis of polyvinylacate surface-grafted by emulsion

system to polyvinylalcohol. The crosslinking created the biodegradable metal adsorbent from chitin and chitosan. Gel sheet for on-site metal analysis sheet was developed by incorporating hydorxypropyl cellulose with coloring agent. The wall paper and dumy lens are industrial applications of crosslinked carboxymethyl cellulose and polylactic acid, respectively.

3. Application of Radiation Processed Oligo-chitosan as Plant Growth Promoter in Indonesia by Field Test by Dr. Taswanda Taryo (Deputy Chairman, BATAN)

Preparation of liquid oligo chitosan has been successfully develop at laboratory scale and continue to semi pilot plant production. This experiment was to investigation of condition of chitosan such as molecular weight and viscosity for irradiation in semi plot production. Irradiation was using gamma ray from Co-60 at IRKA radiator facility , PATIR-BATAN. The results show that for pilot plant production of liquid oligo chitosan, the molecular weight of chitosan must be standartiation around 8000 – 10.000 g/mol with viscosity of 100 – 200 cPs. Irradiation method is effective for reducing of molecular weight and viscosity of chitosan. The IRKA irradiator facility at PATIR-BATAN could be used for pilot production of oligo chitosan with max capasity of 1000 L/batch.

The field test of oligo chitosan was done in Bogor, west Java, 1100 m osl and pH 6,0. The treatment was same ussualy as the farmer done the different was only added of oligo chitosan . The mother liquor of oligo chitosan (2 g/L) was dilute with water to 50 ppm. The solution was spray to the chili plant twice a week around 300 mL / plant. Results of field test showed that by spraying water contents of oligo chitosan made the productivity increase around of 0.25 kg/ plant.

Chitosan is antimicrobial against a wide range of target organisms. Activity varies considerable with the type of chitosan, the target organism and the environment in which it is applied. There are several factors, both intrinsic and extrinsic, that affect the antimicrobial activity of chitosan. It has been demonstrated that lower molecular weight chitosans have greater antimicrobial activity than native chitosans. The irradiated chitosan more effective for growth inhibition of *E. colli* compare *staphylococcus aureus* bacteria

4. Industrial Application of Radiation Processing in Indonesia

4.1 Possibility of EBM Technology in Industry (hope and usefulness) by Mr. Thomas Darmawan (Indonesia Trade Chamber)

There are increased in utilizing EBM technology in industry due to global competitiveness and standardization demand of quality to be exported, particularly in safe and healthy food industry.

More information on food industry using EBM is required, as so far the radiation processing used is the irradiation 60Co, particularly the exposure. Products of radiation processing using EBM are still depend on customers acceptance. Where there is a high consumers acceptance, it becomes a trigger for private sector to invest radiation EBM processing. Promotion of radiation and/or EBM processing products is still required. Radiation and/or EBM processing in food industry may increased export on food packed. It is hoped that EBM investment for industry less than the Gamma 60 Co facility.

4.2 EBM for Latex Prevulcanization by Dr. Widi Setiawan, Ratan (Batan)

Vulcanization of rubber processing can be done using conventional (chemical) or EBM technique, and environmentally safe. The EBM available in BATAN is obsolesce (aging) and requires heavy maintenance, where parts needs modification to suppress operational cost. Rubber plant industry is quite large in Indonesia and has a potential to increase economic stability, particularly at the level of rubber plant farmers. Result study on the development of EBM in BATAN leads to possibility of EBM manufacture. There are still weakness of EBM manufacture in BATAN , such as electron gun defective and continuous beaming electron. Improvement has already been made through on-goin g collaboration with Japanese Seiki Co.

4.3 EBM experiences in Tyre industry by Mr. Andry Andryan (Bridgestone Tyre Industry)

EBM improves tire manufacturing. The process of tire production using EBM found obstacles to maintain the EBM. High cost and time length in improving EBM's parts are the major constrains. It is expected those major problems can be overcome through this workshop

5. IAEA Activities on Radiation Processing Applications by: Dr. Khairul HJ MOHD DAHLAN, IAEA/RCA Project Lead Country Coordinator

IAEA was established in 1957 with the mandate to promote safe, secure and peaceful nuclear technologies. IAEA works on three pillars namely nuclear verification and security, safety and technology transfer. Departments of Nuclear Sciences and Applications and Technical Cooperation are the two Departments that promote and coordinate activities in relation to Radioisotope Production and Radiation Technology. Under Radiation Technology, there are two programs namely Radiation Technology for Advanced Materials Development and Remediation of Pollutants using Radiation Technology. The following are the activities that related to Radiation Technology namely:

1. Fostering Relevant Developments and Dissemination of Information:
    - Coordinated Research Projects (CRP)
    - Thematic Topical Meetings (Technical & Consultancy)
    - Publication of Technical Reports and Documents
2. Technology Transfer & Capacity Building:
    - Technical Cooperation Projects – Regional & National
3. Support to International Meetings:
    - IMRP, IRaP, Tihany…

The following are the current CRP that are participated by 16-17 member states from developed and developing countries.

- Development of Novel Adsorbents and Membranes by Radiation-Induced Grafting for Selective Separation Purposes (2007-2011)
- Development of Radiation-processed Products of Natural Polymers for Application in Agriculture, Healthcare, Industry and Environment (2007-2011)
- Nanoscale Radiation Engineering of Advanced Materials for Potential Biomedical Applications (2008-2012)

For future activities, the following areas of research and technology development are expected:

- Radiation Processing for Remediation of Organic Pollutants in Solids and Aqueous Environment
- Treatment of Bio-hazardous Contaminants by Radiation Processing
- Radiation Processing of Composites

IAEA is also supporting Technical Cooperation projects in many developing member states at national and regional levels. Several IAEA Collaborative Centres have also been appointed and Malaysia has been appointed as the IAEA Collaborative Centre on Radiation Processing of Natural Polymers.