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**UNITED NATIONS INDUSTRIAL DEVELOPMENT
ORGANIZATION**



**INTERNATIONAL CENTRE FOR SCIENCE AND
HIGH TECHNOLOGY**

BAHRAIN CHEMICAL SOCIETY (BCS)

ARABIAN GULF UNIVERSITY

FINAL REPORT

Workshop on

**“Sustainable Polymers: Promotion of EDP Concept
in Middle East and Gulf Countries”**

5-8 November 2001

Bahrain

OBJECTIVES

The Workshop was planned and organized with the following main aims and objectives:

- a. To discuss present issues related with Environmentally Degradable Plastics (EDPs) with the main focus on industrial development and its related applications.
- b. To understand and demonstrate recent developments worldwide in terms of manufacturing and processing technology of EDPs.
- c. To provide participants from Developing Countries and GCC region with updated knowledge and information on EDPs in terms of waste management of polymeric materials.
- d. To raise public awareness and refine perceptions on the issues of environmental effects and related impact of plastic and to emphasize the positive contribution of EDPs in waste management of polymeric materials.
- e. To stimulate research and technology transfer at national, regional and international level and enhance cooperation through possible, joint or follow-up projects and feasibility studies by identifying regional R&D centers in developing countries thereby giving ICS the possibility of identifying qualified academic and industrial centers for future joint ventures for the EDPs development.

ORGANIZATION

With the above aims and objectives, ICS-UNIDO and Bahrain Chemical Society (BCS) in cooperation with Arabian Gulf University (AGU) jointly organized the workshop.

The International Scientific Committee consisted of:

- Mr. Stainislav Meirtus (ICS-UNIDO, Italy)
- Emo Cheillini (Univ. of Pisa, Italy)

The local organizing committee consisted of:

- Chairman: Dr. Saeed Al-Alawi
Bahrain Society of Chemists
University of Bahrain
- Khawla Al-Khalaifat
Arabian Gulf University
- Ali Al-Aradi
Bahrain Petroleum Company (BAPCO)

DATES AND VENUE

The workshop was held from 5 – 8 Nov. 2001 at Arabian Gulf University.

WORKSHOP BUDGET

The overall amount of funds approved by ICS-UNIDO was of US\$ 12,000 to cover travel and full board accommodation expenses of all invited speakers and participants from abroad. US\$ 9,600 were received before the beginning of the workshop. The estimated local contribution amounted to US\$3,700.

PARTICIPATION

Participation of ICS-UNIDO Experts

Five experts recognized by ICS-UNIDO participated in the workshop. These experts were from Slovakia, Austria, Italy, Slovenia and Egypt.

Foreign and Local Participation

In total 21 delegates from Kuwait, Iran, Bahrain, Hungary, UAE participated in the workshop.

PROGRAMME

Lectures and Presentations

In total 18 lectures were delivered during the three days of the workshop. 10 lectures were given by ICS experts and the remaining 8 lectures were presented by local, regional and international participants. Out of the latter presentations, 2 lectures were given by technical managers of two manufacturing companies of marketing Environmentally Degradable Plastics.

Half of the last day was dedicated to the panel discussion on *How to promote the EDP concept in this region.* The summary of the panel discussion is given in the end of this report.

Workshop's Promotion and Participation

For promotion and publicity of the workshop, a circular containing summary of the program along with some keynote speakers were distributed in Bahrain and other GCC countries. In addition, also to get participants from organizations and ministries in Bahrain, personal meetings were planned and organized with local authorities, ministers, governmental departments, industries and other local organizers of the workshop.

Exhibition during Workshop

Two manufacturing companies marketing and popularizing Degradable Plastics participated in the Workshop Exhibition and demonstrated their products. One company from Hungary exhibited photodegradable plastic product and the other company exhibited Thermal Degradable Plastics. One local company

manufacturing non-degradable plastics also exhibited their products in the workshop.

SITE VISITS

A site visit was arranged on Tuesday , 6th of Nov. afternoon to Al-Zeera Plastic Company. The purpose of this visit was to witness the production and recycling process of plastic waste. Participants had the opportunity of looking at the variety of products manufactured from non-degradable plastics. The management of this company also showed interest towards the manufacturing of degradable plastics.

WORKSHOP MATERIALS

Each participant and lecturer was provided with the workshop program, abstracts of lectures and presentations along with the list of participants and their addresses. All this information was placed in a folder and provided to all participants in the workshop. The sample of Degradable Plastic Bag provided by SZEVIKI Organic Chemical Industrial Research Institute Co. Ltd. Hungary was also distributed. The samples of semi-thermodegraded plastic were also distributed to participants of the workshop. A group photograph of all participants was taken and provided to them.

2. WORKSHOP PROGRAMME

The details of the programme are reported below:

Opening Ceremony

The opening ceremony was organized on the first day of the Workshop i.e. on 5th November, 2001 and was attended by the President, Vice- President and Dean of Higher Education of Arabian Gulf University. The President of Bahrain Society of Chemists, Heads and representatives of many NGOs and academics from University of Bahrain and other related institutions attended the ceremony along with invited guests from the local professional community.

The President of Arabian Gulf University delivered the opening welcome speech, she stated that the Arabian Gulf University can host any activity related to the environment and welcomed the initiation from local institutions, societies, NGOs and other international organizations.

Prof. Emo Chiellini delivered a speech on behalf of the Director of ICS Prof. Miertus regarding the role of ICS-UNIDO in promoting several activities in the developed world and especially in developing countries.

The final speech of the opening ceremony was delivered by the Dr. Saeed Al-Alawi, the local organizer from Bahrain Society of Chemists. He highlighted the various activities of the Society in promoting different environmental programmes in Bahrain.

The detailed workshop programme is given below:

First Day: Monday 5th .Nov. 2001

8:30 – 9:00 **Opening Ceremony**

- i. Speech of the President of Arabian Gulf University
- ii. Speech of Prof. Emo Chiellini in place of Prof. Stanislav Miertus:
Director of ICS-UNIDO
- iii. Speech of Dr. Saeed Al-Alawi; Local Organizer of EDP workshop

9:30 – 10:00 Coffee Break

10:00 – 10:15 Prof. Emo Chiellini

“ ICS-UNIDO Program on EDP” Followed by Discussion.

10:15 – 11:00 Prof. Sherif Kandil; Department of Material Science, Institute of Graduate Studies and Research Alexandria University, Alexandria, Egypt,

“ Plastic within the Solid Waste Management Matrix”

11:00 – 11:45 Mr. Rehan Ahmed; Environmental Affairs; Ministry of State, Municipality Affairs and Environmental Affairs, Bahrain
Plastic Waste Management in Bahrain

11:45 – 12:30 Ms. Khawla Al-Mohandi; Electronic Environment Society (NGO's Organization)

Plastic Bags in Bahrain

12:30 – 14:00 *Lunch Break: Sponsored by Arabian Gulf University*

14:00 – 14:45 Prof. Andrej Krzan; National Institute of Chemistry
Laboratory of Polymer Chemistry and Technology, Ljubljana, Slovenia

Plastic Recycling: An Overview

14:45 – 15:30 Prof. Dusan Bakos; Faculty of Chemical and Food Technology
Slovak University of Technology in Bratislava, Slovakia

Biodegradable Polymers in Biomedical Application.

15:30 – 16:00 General discussion

Second Day: Tuesday 6th Nov. 2001

9:00 – 9:45 Prof. Emo Chiellini; Department of Chemistry & Industrial Chemistry
University of Pisa, Italy.

“ Sustainable Polymeric Materials & Plastic. Role & Position of Environmentally Degradable Plastics”.

9:45 – 10:30 Prof. Dusan Bakos; Faculty of Chemical and Food Technology
Slovak University of Technology in Bratislava, Slovakia

“ Follow up of EDP's Workshop in Smolenice, SK – A Case Study”

10:30 – 10:45 Tea/coffee break and side discussion

10:45 – 11:30 Prof. Gerhart Braunegg
Production of Biopolyesters from Renewable Resources and Fossil Resources.

11:30 – 12:00 Hallel A. Rahman; Posford Duvivier Environment Gulf
Environmental Impact of Manufacturing Plastic

12:00 - 12:30 Al-Zeera Plastic Company Presentation
Recycling Process in Al-Zeera Plastic Company

12:30- 14:00 Lunch Break: Sponsored by Al-Zeera Plastic Company

14:00 – 16:00 **Field Trip to Al-Zeera Plastic company**

Third Day: Wednesday, 7th Nov. 2001

9:00 – 9:45 Prof. Emo Chiellini; Department of Chemistry & Industrial Chemistry
University of Pisa, Italy.
“CEN Activity in Norms and Standards for EDPs”

9:45 – 10:30 Prof. Gerhart Braunegg
“ARA and Dual System; Plastic Waste Management in Austria and Germany”

10:30 – 11:00 Coffee break and Side Discussion

11:00 – 11:45 Prof. Gyula Kortvelyessy; Chemical Industrial Research Institute Co. Ltd.
“Sensilene, is a Photosensitizing Additive for Photodegradable Polyolefin”

11:45 – 12:30 Dr. Khalid Habib. Kuwait Institute Research
“General Model of Hydrogen Transport through porous Organic Membranes”

12:30 – 13:00 Mr. Winston Pryce; Tuffy manufacturing of Polyethylene Degradable Plastic.
“Presentation of Polyethylene Degradable Plastic characteristic.”

13:00 – 14:00 Lunch Break: Sponsored by Bahrain Petroleum Company

14:00 – 14:45 Mr. Mani Esmaeil ; POLFAN Sepahan Company-IRAN
“Conversion of PET to reinforced GF-PET”

14:45 – 15:15 Prof. Andrej Krzan; National Institute of Chemistry
Laboratory of polymer Chemistry and technology, Ljubljana, Slovenia
“Measuring and Certifying Biodegradation of Plastics”

15:15 – 16:00 General Discussion

Fourth Day: Thursday 8th Nov. 2001

9:00- 12:00 Panel Discussion:
How to promote EDP in Gulf Region

*Awarding Ceremony of the Attendance Certificates
and closing ceremony.*

CLOSING CEREMONY

The closing ceremony was planned as a panel discussion in which the concept of EDPs and its promotion in Bahrain in general and in GCC region in particular was discussed. The outcomes are mentioned in the next section of this report.

Certificate of Attendance

At the end of the panel discussion on the last day of the Workshop, a certificate of attendance was distributed to all participants.

Presentation of CD

At the end of the closing session, a CD containing all lectures and presentations given by lecturers was distributed among participants in the workshop.

SOCIAL EVENTS

Lunches during the first, second and third day were sponsored by Arabian Gulf University, Al-Zeera Plastic company and Bahrain Petroleum and Refinery Company respectively. All participants were invited. On the second day, the international guests were invited for an exclusive dinner sponsored by the Dean of Higher Education Studies, AGU. The dinner on the third day was sponsored by the Bahrain Society of Chemists for all participants.

Tour around Bahrain

On the last day afternoon of the Workshop, a tour around important locations in Bahrain was organized for all international participants by the Arabian Gulf University.

SUMMARY OF WORKSHOP ASSESSMENT

The summary of issues and discussions made during the closing ceremony is briefly mentioned as follows:

1. The NGOs working in Bahrain are dedicatedly involved in environmental issues and they are working with the cooperation and assistance of environmental authorities in the country.
2. The EDPs concept is assessed to be incorrectly understood by the public and decision-makers, as it is targeted to solve the problem of littering of plastic bags.

EDPs concept is to help the environmental disposal of plastics and in solving the problem of waste management.

3. The problem of plastic waste management and its impacts were discussed. It was agreed to plan, prepare and implement an integrated and well-defined strategy to address the problem.

4. The need for review and evaluation of existing legislation on plastic production and waste management needs to be reviewed and evaluated. The gradual substitution of non-degradable plastic to degradable plastic needs to be planned and implemented.

5. A meticulously planned dedicated project on the concept of EDPs was discussed and approved by participants involving all related stakeholders and especially industries.

6. The plastic consumption in GCC Countries was assessed to be very high in comparison with other countries of the region.

7. ICS-UNIDO was requested to provide the Organizers with an information package on EDPs and to prepare and submit a dedicated Training package on EDPs to help in promoting EDPs in the region. This training package is available at ICS.

8. The experts from ICS offered the opportunity to facilitate the transfer of technology on Degradable Plastic production to those companies and industries that intend to adopt the technology.

9. In order to facilitate the adoption and promotion of EDPs in this region, the discussion was held in appointing focal points in this region. It was recommended that Bahrain could be made as the focal point for GCC countries. On the other hand, participants from Iran showed their interest to be a focal point for Iran, as Iran has special problems related to Plastic Waste Management.

5. WORKSHOP EVALUATION

The assessment and evaluation of the workshop was done by providing an optional questionnaire, which was distributed, to all participants and lecturers. The results of the evaluation are mentioned below:

Organizer and Overall Organization

The overall organization with regard to the announcement of the workshop, information process, program, training room facilities and other related matters in organizing the workshop was rated as excellent.

The International Speakers

The materials presented by the international speakers and also their knowledge in responding to questions was rated as excellent.

The Case Study and Performance of the Local Lectures

The materials presented by the local lecturers and case studies presented were rated as good. This assessment was mainly made due to the lack of knowledge regarding plastic in general and EDPs in particular in this region. The recommendation was made by some participants, that more workshops on similar topics need to be arranged in the region to provide more information and scientific knowledge about plastics as well as on the new emerging and practiced technologies of EDPs.

Time and Duration of the Workshop

Although most of the participants mentioned that the duration and numbers of sessions planned in the workshop were just right, it was felt and observed that the local participants could not dedicate the entire time to the workshop due to their other official and work commitments. Besides, sparing the professional employees and staff by many companies was found difficult by the Employers.

General Comment from the Participants

Many comments and observations indicated the need of organizing more scientific workshops for transferring the knowledge on plastics and EDPs in this region. Major comments also indicated that the panel discussion in the last session of the workshop was very useful, because it was a general discussion regarding the subject in which foreign experts gave their informal views and strategy. The requirement and need to develop a new plan and strategy for the region was highlighted by many participants.

CONCLUSIONS AND RESULTS

In this workshop the introduction to EDPs from different perspective and application in different fields with a focus on industrial development were presented. Local speakers from different organizations updated participants of the workshop with the current situation of plastic waste management in Bahrain. The representatives of some NGOs highlighted the various social and environmental problems being faced by the use and disposal of plastic bags.

A representative of a plastic company in Bahrain informed participants on the recycling process in the company to reduce plastic waste during the production process.

A company specialized in producing photodegradable plastic bags exhibited its products with a given introduction about the process and characteristic of the products. Another company exhibited its thermo degradable plastic products. A third company exhibited the recycling of PET to produce reinforcement of PET.

Participants in this workshop were from different organizations and agencies with inadequate knowledge of the subject. They were made aware of the actual problem of plastic waste management. Many participants had insufficient information on EDPs.

The workshop was successful and achieved its objectives, which are reflected in the following points.

1. Even though the number of participants invited to attend the workshop was limited, they represented key organizations dealing with plastic management. These participants were made aware of problems related to plastic waste disposal.
2. From the panel discussion it was observed that the region has a genuine problem regarding plastic waste management. All the present environmental organizations expressed their willingness to work in harmony to overcome the problems of plastic waste. Similarly the NGOs were found ready to help with governmental organizations and agencies to solve the relevant problems.
3. It was assessed that there exists not enough knowledge regarding the subject of Plastic waste Management in the region. People need to be educated and made aware of the problem, the authorities need to be convinced for planning, designing, devising and implementing strategies on EDPs.
4. The concept of EDPs and its promotion needs to be initiated at the earliest in the region with all the regional, international and national organizations offering genuine support and help.

- 5 The government should encourage the industries for promotion of EDP in this region. This could be done by preparing and implementing a legislation and enforcement for adopting EDPs in this region.
6. UNIDO through its organization can help in organizing a project for the promotion of EDP in Bahrain as well as in the GCC region.

ANNEX 1: List of participants

ANNEX 2 Book of Abstracts

ANNEX 1

ICS - UNIDO

Workshop on

“Sustainable Polymers”

Promotion of Environmentally Degradable Plastics (EDP) concept

In the Middle East and the Gulf Countries

5-8 November 2001, Bahrain

Name	Position	Address	Fax/Tel. Mobil	e-mail
G.Braunegg	University Professor	Institute of Biotechnology Tugraz Petersgasse 12 A-8010 Graz - Austria	++43-316-873-8434 ++43-316-873-8412	braunegg@biote.tu-gtaz.ac.at
Emo Chiellini	University Professor ICS-UNIDO Advisor on EDPs	Department of Chemistry University of Pisa 56126 Pisa - Italy	TEL +39-050- 918299 Fax+39-050-28438	Chlmeo@dccci.unipi.it
Nayel Moh'd. Nayel	Amiri Vet. Unit Manager	Amiri Court Bahrain P.O. Box: 28532	Fax: 750715 Tel.: 754270 Mob.: 96414911	Sabeel@Batelco.com.bh

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Name	Position	Address	Fax/Tel. Mobil	e-mail
Saeed Al-Alawi	Prof. University of Bahrain Chemistry Dept.	P.O. Box 32656	Tel:+973-9626776 Fax. +973-250000	Saeed244@batelco.com.bh
Khawla Ebrahim	Instructor: Arabian Gulf University	P.O. Box 26671 Bahrain	Tel: +973-239855	khawla@agu.edu.bh
Ali Al-Aradi	Senior Chemist Bahrain Petroleum Company	Bapco Refinery Refinery Lab.	Tel: +973-755086 Fax. No. +973- 655099	Ali-alaradi@bapco.net
A. Karim Hassan Rashid	Environmental Specialist	Environmental affairs P.O. Box: 26909 Manama-Bahrain	Fax: 293694 Tel: 319107 Mob. 9275570	Kme200@hotmail.com Or Abdulkareemh@Bahrain.gov.bh

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Name	Position	Address	Fax/Tel. Mobil	e-mail
Karim Moahmed Sulaybikh	Head, standard and Information	Directorate of Standards and Metrology Ministry of Commerce And Industry	Fax: 530730 Tel: 523033	bsmd@batelco.com.bh
Ahmed Omar Ba-About	Environment Electroic Friends (EEF) member Industrial Eng.	Dhahran , 31311 Box : 5366 Saudi Arabia, Saudi Aramco	+966548411072	baabaoa@aramco.com.sa
Dr. Abubaker Mohamed Ibrahim	Head/ Amiri Court Lab. Vet. Unit	P.P. Box: 28532 Bahrain	Tel: 750715	Sabeel2@batelco.com.bh
Farzaneh Moshayedi	Expert of Department of environment	Tehran-I.R. Iran Hemat High way-Pardisan Park-center of Researches Soil and water pollution and waste Boreau-second floor	Fax(+9821)8264003 Tel:(+9821)82680404 (2248) 8267992	Fmoshyedi@yahoo.com f-moshayedi@irandoe.org

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Name	Position	Address	Fax/Tel. Mobil	e-mail
Dr. Mojtaba Ardestani	Adviser to national Petrochemical Company (NPC) of Iran	NPC. Karim Khan Sq. Tehran- IRAN	Tel/fax +9821-8824317	m_ardestani@yahoo.com
Alak Kumar Guha	Production Manager Zeera United Factories Bahrain	P.O. Box: 696 Manama -Bahrain	+973-731333 +973-730333 +9739-9691955	Zeera@batelco.com.bh
Khawla Al- Muhannadi	President and Founder Environment Electrocnic Friends EEF(NGO)	P.O. Box 37714 Bahrain	+973 750700 +973 294192	environmentfriends@yahoo.com Kmuhanadi@yahoo.com
Fadhel Abbas Yousif	Head of Operation	P.O. Box: 53 Manama, Bahrain	Tel.: (+973) 784433 Fax: (+973) 785494	f.yousif@yahoo.com

ICS - UNIDO

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Name	Position	Address	Fax/Tel. Mobil	e-mail
Dusan Bakos	Professor slovak University of Technology	Radlinszilog Bratisland 81237	+421-2-52495260 Fax: +421-2- 52495381 Mob. 0903 238191	Bacos@cut.stuba.sl
Gyula Kortvelyessy	Secretary General	Bimbo 30, Budapest Hungary H-1022	+361 31 65410 Fax: +361 3360005	KORTVE@AXELERO.HU
Helei K. Y. Abdul Rahman	Environment Consultance Posford Duvivier Environment Gulf	P.O. Box 10379 Manama	Tel:+973-533259 Fax. +973-533754	pdegulf@batelco.com.bh
E.Mani	Managing Director POLFAN, Eng. CO.	N0. 159 161 Apadana Cross-Road Sajad Ave. Esfehan Iran P.O. Box 81655/673	Tel.+98 311 612220 Fax.+98 311 620985	mani@pershia.net

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Name	Position	Address	Fax/Tel. Mobil	e-mail
Khalid Habib	Researcher Kuwait Institute for Research and Study (KISR)	P.O. 24885 Safat 13109 Kuwait		khalehabib@usa.net
Rehan Ahmed	Senior Environmental Specialist Environmental Affairs	P.O. Box 26909 Bahrain	Tel: +973-319135 Fax: +973-310653	Rehan900@hotmail.com rehan@batelco.com.bh rehan@bahrain.gov.bh
Mr. Winston Pryce	Managing Director Bin-hilal Enterprises (Tuffly Degradable)	P.O. Box 7349 United Arab Emirates	Tel: +9712-6268010 Fax: +9712-6275128	bhe@emirates.net.ae
Mehdi Hassan	Sales Executive	Abdulla Ahmed Nas & sons P.o. Box 669	Tel +973-703123 Mobil +973-9627560	nasscom@batelco.com.bh

Dr. Zahra Sadiq Al-Alawi	Senior Marine Biologist	Directorate of Fisheries & Marine resources	Tel: +973-729595 Tel: +973-810244 Fax: +973-728459	
Mr. Masayuki Shida	Consultance on Waste Management. Japan International Cooperation Agency	Environmental Affairs P. O. Box 26909 Bahrain	Tel: +973-319109 Fax: +973-293694	

ANNEX 2

BOOK OF ABSTRACTS

SUSTAINABLE POLYMERIC MATERIALS & PLASTICS. ROLE & POSITION OF ENVIRONMENTALLY DEGRADABLE PLASTICS

Emo Chiellini

*Department of Chemistry & Industrial Chemistry
University of Pisa, 56126 Pisa, Italy*

Synthetic and semisynthetic polymeric materials were originally developed for their durability and resistance to all forms of degradation including biodegradation. Special performance characteristics are achieved in items derived therefrom through the control and maintenance of their molecular weight and functionality during the processing and under items operative conditions. The polymeric materials had been and are currently widely accepted because of their ease of processability and amenability to provide a large variety of cost effective items that helped enhance the comfort and quality of life in the modern industrial society. However the above quoted features, that make the polymeric materials so convenient and useful to the human life, have contributed to create a serious plastic waste burden, sometimes unfairly oversized by media because of the visible spreading of plastic litter in the environment and the heavy contribution to landfill depletion due to the unfavorable weight to volume ratio of plastic items that is in average 1 to 3.

On the other hand the expectations in the 21st century for polymeric materials demand are in favor of a 2 to 3 fold increase production, thus overcoming the world-wide annual mtons production of paper (250 Mil./tons) as a consequence of the increase of the plastics consumption in developing countries. Indeed a one-two order of magnitude jump in the plastics consumption with respect to the present annual level of 2 Kg (India) –15 Kg (China) procapite can be envisaged for those countries once the living standards of industrialised countries with an annual average consumption pro-capite of about 100 kg will be approached.

The design, production and consumption of polymeric materials for commodity and specialty plastic items have certainly to face all the constraints and regulations already in place or to be issued in the near future, dealing with the management of primary and post-consumer plastic waste. In this connection the formulation of environmentally sound degradable polymeric materials and relevant plastic items will constitute a key option among those available for the management of plastic waste. The competition with the presently adopted technologies such as burial in landfill sites, incineration with energy recovery and mechanical or chemical recycling is expected to be strengthened, even though one may predict that all of them will coexist with an appreciable decrease of landfilling practice and the introduction of the new concept of prevention that should help to rationalize the production and management of plastic waste. The technologies based on recycling, including also the

energy recovery by incineration, will be flanked by the increasing option of environmentally degradable plastics. These should be designed to replace the conventional commodity plastics in those segments in which recycling is difficult and labour-intensive with hence an heavy penalization on the cost-performance of "recycled" items, as a downgrading of the original material properties is occurring both during the life-time of the items meant to be recycled and their reprocessing stages once they reached the recyclable items rank.

An overview on environmentally degradable polymers and plastics cannot therefore be treated outside of the framework of the global issue related to the waste production and relevant management. The position held by environmentally degradable plastics will be analyzed in terms of the development levels so far reached and of the future perspectives. It is worth mentioning that a major aspect that has attracted the attention of plastic manufacturers, polymer scientists, and public officers, is represented by the establishment of definitions comprising all the possible categories of environmentally degradable polymers and plastics, together with suitable standards and testing protocols. The nature and fate of the degradation products constitute another crucial point for the acceptance of environmentally sound synthetic polymeric materials undergoing degradation under specific environmental conditions.

A picture will be finally provided of the potential and effective impact of environmentally degradable plastics on the world-wide market of polymeric materials.

Plastics Within the Solid Waste Management Matrix

Sherif Kandil,

*Department of Material Science, Institute of Graduate Studies and Research,
Alexandria University, Alexandria, Egypt.*

We are living in the “Plastic Age”. Its use has expanded greatly. In the middle of the past century, the production of one type of plastics, nylon, was enough to rap the earth planet. It was expected that by the end of the 20th century, the earth would be buried in plastics, which almost happened. The packaging industry contributes greatly to this waste as it consumes 20 – 40% of the plastic production. Moreover the average life span of plastic in packaging is less than one year.

The recycling of plastics starts as early as the collection step. The plastic could be sorted out manually or automatically, crushed and then processed through one of the followings:

1. Mechanical Recycling, where the plastic could be reprocessed to similar products, or new products of inferior quality. This process is wide spread in the plastic industry and probably needs regulations and standards in our part of the world.
2. Feedstock Retrieval, where the basic chemicals could be retrieved from plastics through hydrolysis or pyrolysis.
3. Energy Recovery, as energy could be recovered from plastics. The heat content of plastics is high and comparable to other types of fuel. Nevertheless environmental precautions should be taken for the hazardous emissions due to the chemical reactions plastics additives through the combustion process.

It is worth mentioning that plastic recycling is an integrated process, and the separation of waste affects the route of recycling and consequently the value of the produced waste as well as the products. A brief analysis of the economics of plastic recycling will be presented. Plastic recycling within the entire solid waste management matrix will be discussed: the chances of the waste minimization, the possibility of its substitution, the methods of its degradation, and the innovative methods for its final disposal. It will be shown that there is no single answer for getting rid of the plastic waste; an integrated approach will always make a better impact. Plastic recycling could be of multiple benefits as it could yield economic revenues, preserve the natural resources, and protect the environment.

Biodegradable Polymers in Biomedical Applications

D. Bakos

Abstract

Biodegradable polymers have found a multitude of uses as biomaterials. The biodegradation may offer several advantages. The biodegradable polymers can be used as implants and engineered to degrade at a required rate. One of the exciting and very progressive areas for applications of biodegradable polymers is in tissue engineering. The biodegradable polymers can serve as a matrix for living cells. Important properties in this regard include porosity for cell in-growth, a surface character for cellular attachment, mechanical properties, degradation rate, and by-products. Although all of the initial products on the market are skin substitutes, the tissue engineering community is addressing a broad range of different tissues. This includes cartilage, tendons/ligaments, bone, blood vessels, and heart valves. Furthermore there are groups working on what might be called the vital organs based on biodegradable polymeric scaffold.

**Polyhydroxyalkanoates (PHAs):
Biopolyester Production from Renewable Resources**

G. Braunegg, R. Bona, M. Koller, F. Schellauf, E. Wallner

Institute of Biotechnology, University of Technology Graz,
Petersgasse 12, A-8010 Graz, Austria
Tel.: 0043-316-873-8412
FAX: 0043-310-873-8434
E-Mail: braunegg@biote.tu-graz.ac.at

SUMMARY

Polyhydroxyalkanoates (PHAs) are biodegradable substitutes to fossil fuel plastics that can be produced from renewable raw materials such as saccharides, alcohols and low-molecular-weight fatty acids. They are completely degradable to carbon dioxide and water through naturally occurring microbiological mineralization. Consequently, neither their production nor their use or degradation have a negative ecological impact. By keeping closed the cycle of production and re-use, PHAs can enable at least part of the polymer-producing industry to switch from ecologically harmful end-of-the-pipe production methods towards sounder technologies.

Up to now such polyesters have been produced biotechnologically from refined raw materials (e.g. glucose and sodium propionate), but they can as well be produced much cheaper and following the principles of sustainability from agricultural waste materials (e.g. molasses, maltose, glycerol phase from biofuel production, whey, fats) as long as these materials have a known composition and are available in appropriate quantities. Beside this environmentally sound technology, medium chain length PHAs can of course as well be produced from petrol-derived alkanes when producing strains belonging to the group of fluorescent pseudomonads (e.g. *Pseudomonas oleovorans*). Other resources for PHA production are alcohols (e.g. methanol) or alkanates, if such compounds are available as surplus bulk chemicals. Yield factors and specific rates for growth and PHA accumulation are shown for some interesting production strains, when different pure and waste carbon sources are used. Process design for PHA production based on kinetics of microbial growth and PHA accumulation will be shown and be discussed.

ARA and Dual System: Plastic Waste Management in Austria and Germany

G. Braunegg, R. Bona, M. Koller, F. Schellauf, E. Wallner

Institute of Biotechnology, University of Technology Graz,
Petersgasse 12, A-8010 Graz, Austria
Tel.: ++43-316-873-8412 FAX: ++43-310-873-8434
E-Mail: braunegg@biote.tu-graz.ac.at

SUMMARY

Due to strict regulations by the Austrian Packaging Ordinance (Law since 1993) and due to the fact that municipal solid waste incineration has not been accepted as a form of energy recovery, plastic packaging waste is collected and recycled throughout this country. In 1998 not more than 90.000 tons of plastic waste may be landfilled, and in 2001 this quantity will be further reduced to 60.000 tons per year. Moreover, the share percentage of mechanical recycling is individually fixed for several packaging materials, e.g. 40% for plastics, cardboard composite drink packaging, and other composites, related to the total amount of transport and sales packaging.

All producers and importers of packed goods, fillers, and packers are responsible for collection and recovery of their packaging. A system (ARA) has been set up for effective recovery, sorting, and recycling of waste packaging materials and is financed by fees that have to be paid for the packaging waste. Recovery is executed in seven national and two foreign plants.

In 1997 a total of 83.416 tons of plastic waste has been collected in Austria (37,9 % of the total plastic waste). 45% of this could be reused (sorted qualities), the rest (46101 tons) was used for energy recovery under strict governmental regulation and control.

In Germany a very similar approach, the Dual System, was founded in 1990 as a Company for waste avoidance and recovery of secondary raw material. In 1991 the "Ordinance on the Avoiding of Packaging Waste" came into force, obliging manufacturers and the retail trade to take back sales packaging after use and to forward it for recycling. On the European level, the European Parliament and Council Directive 94/62/EC on packaging and packaging waste came into force. Its key issue is that each member state must take measures to set-up take-back, collection and recovery systems for used packaging by the year 2001.

Details about the systems used and statistical data about collection and reuse of collected plastic materials will be presented.

Plastics Recycling: An Overview

Andrej Krzan

National Institute of Chemistry
Laboratory for Polymer Chemistry and technology, Ljubljana, Slovenia
andrej.krzan@ki.si

Over the past half century global plastics use experienced a growth higher than any other major material group, and the trend is likely to continue in the foreseeable future. The fact that a large part of plastics applications have a useful life-time much shorter than the life-time of the material itself results in large quantities of "good-quality" plastics finishing as part of industrial or municipal wastes. Recuperating the potential value of these materials as secondary raw materials or as energy while preventing land degradation is the aim of recycling. This makes recycling an issue of both economics as well as the environment.

Plastics can be recycled through many routes that can generally be classified as either material recycling or energy recycling. However, the vast array of polymer types in use disallows a common treatment of all plastics. This limitation requires separation of materials, which combined with cleaning and collecting represents the largest economic and environmental burden of the recycling process. It is thus necessary to apply a number of criteria to make sure that recycling of a certain plastic waste by a selected method makes economic and environmental sense. Through an objective approach the recycling industry can avoid some of the volatility stemming from unreasonable practices and expectations while at the same time offering benefits to the economy and society.