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OCCASION

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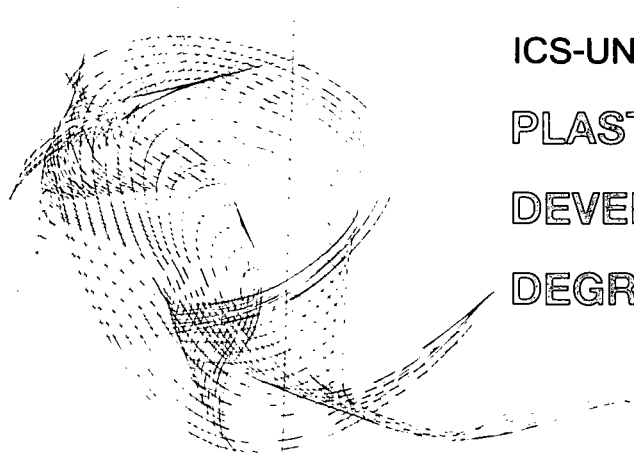
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FINAL REPORT



ICS-UNIDO INTERNATIONAL WORKSHOP
PLASTICS RECYCLING AND
DEVELOPMENT OF ENVIRONMENTALLY
DEGRADABLE PLASTICS

21-23 October 2002

Sol Twin Towers Hotel, Bangkok, Thailand

UNIDO PROJECT NO : TF/GLO/00/105

CONTRACT NO : 2002/196/IR

FINAL REPORT

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INTRODUCTION

ICS-UNIDO International Workshop on Plastics recycling and Development of Environmentally Degradable Plastics was organized by The International Center for Science and High Technology (ICS), which is an institution within the legal framework of the United Nations Industrial Development Organization (UNIDO), and the National Metal and Materials Technology Center (MTEC).

Thailand was selected as the Workshop venue as Plastics waste management is a growing concern in many developing countries, including Thailand. Also, the Environmentally Degradable Plastics is relatively new concept in Thailand which needs promotion for better public and industrial understanding. The ICS-UNIDO workshop, meeting and training will provide an opportunity for participant to broaden their perspectives to advanced and innovative technology. The National Metal and Materials Technology Center (MTEC) can help promote plastic waste treatment and EDP research in Thailand and acts as a focal point for development.

Objectives:

The main objectives of the meeting are:

1. To raise public awareness on the impact of increased plastic production and waste on the environment, and to emphasize the positive contributions of environmentally degradable plastics (EDPs) to the environment.
2. To introduce and to transfer the recent industrial and academic developments and the actual application of plastics recycling and EDP.
3. To stimulate international research and technology transfer and enhance international co-operation through possible collaboration and joint projects.
4. To help ICS in identifying qualified academic and industrial centers for future joint ventures for EDPs development.

The meeting program includes lecture sessions as well as short presentations and exhibitions covering the following topics,

1. Plastic Recycling
2. Plastic Waste Management
3. Preparation and Properties of Environmentally Degradable Plastics (EDPs)
4. Application of EDP
5. Manufacturing of EDP and Related Products
6. Standards and Test Methods of EDP
7. Policy, regulation, legislation associated with plastics waste and public awareness.
8. Country Reports

Local Organizing Committee:

The National Metal and Materials Technology Center (MTEC), Thailand organized the workshop in cooperation with ICS-UNIDO. The local organizing committee comprised,

Chairman : Krisda Suchiva
Secretariat : Thanawadee Leejarkpai
Members : Wanngam Weeraphasuk
Pawadee Methacanon
Chaiyaporn Pomchaitaward
Kongkiat Kongsuwan
Manisara Apisitamornkul
Kobkul Amonmongkul

Date and Site:

The Workshop was held at the Sol-Twin Tower Hotel, Bangkok, Thailand on October 21-23, 2002. The facility provides both accommodation including meals and conference hall equipped with projecting and audio tools.

Funding:

The total expenses for the organization was 1,064,096 Baht which is around 24,184 USD. The amount received from UNIDO was 12,000 USD at the day of signing the contract and additional of 3,000 USD after the final report is received and accepted by the United Nation Industrial Development Organization. The excess of 9,184 USD is covered by the fund of the

National Metal and Materials Technology Center, Thailand. (See appendix I for details of the expenses for the organization of the Workshop)

Participation:

In total, 138 persons from 16 countries participated in the Workshop, among them 17 are from abroad and 121 are domestic participants. Domestic participants were selected from both academic institution and industry. The Workshop program consisted of lecture sessions as well as short presentations focusing on development of plastics waste management by recycling and progress in productions and application of EDPs.

1) Lecturers

22 Speakers were invited to give total of 28 lectures (see Appendix II for the program of the Workshop). However, Prof S. H. Kandil from the Dept. of Material Science, Alexandria University, Egypt, who was invited to give a lecture on the topic "Plastics within the Solid Waste Management Matrix" on 22nd October, was unable to attend the Workshop due to urgent personal matter. Dr A. Krzan from the National Institute Of Chemistry, Slovenia, kindly gave us a cover presentation on the topic " ICS-UNIDO Regional Networking: Focal points.

Table 1 Keynote Speakers

<u>Lecturer</u>	<u>affiliation, country</u>
<u>Topic of the lecture</u>	

S. Miertus ICS-UNIDO, Trieste, Italy

Introduction to the ICS-UNIDO Programs and Activities in the Area of Pure and Applied Chemistry, focussing on the Sub-program of Environmentally Degradable Plastics

E. Chiellini University of Pisa, Italy

1. Environmentally Degradable Plastics -An Overview
2. Standard on Plastics Waste Management in Europe including EDPs

R. Narayan Michigan State University, USA.

1. Biobased Polymeric Materials and Plastics, New Trends and Expectations
2. Standard for Environmentally Degradable Plastics & Biobased Products

G. Swift, G. S. Polymer Consultants, USA

Progress in Design, Production and Commercialization of EDPs

Y. H. Kim, Korea Inst.of science and

1. A review on Biomedical Application of Technology, Korea Biodegradable Polymers
2. Status of Plastics Waste Treatment, Recycling and EDPs Development in Korea

P. N. Lan, Hanoi University, Vietnam

Biodegradable Films Made from LDPE and Modified rice, Cassava Starch and from LDPE and Unmodified starch using Compatibilizer

Y. Tokiwa, National Institute of advanced,

Microbial Degradation of Plastics Industrial Science and Technology, Japan

G. Braunegg, Graz University, Austria

- 1.Sustainable Polymeric Production from Renewable Resources and Agro-industrial Waste
- 2.Report on Solid Waste Management and Plastics Recycling in Austria and Europe

Rapthel Heppe Ltd., Germany

Technology Development for the Production of Biodegradable Materials on the Base of Cassava Starch and Chitosan

K. Suchiva, MTEC, Thailand

Development of EDPs in Thailand

M. Yusman, BPPT, Indonesia

Current Status of Plastics Recycling and EDPs in Indonesia

R. Pinthong, Pollution Control Dept., Thailand

Policy and Legislation of Plastics Waste Treatment in Thailand

S. Wongjaroen, Wongpanit Company, Thailand

Plastics Recycling in Asia

A. Hiranpradit and S. Atichatsrisakul Thai EPS Recycling Group

Recycling of EPS Foam

A. Krzan, National Inst. Of Chemistry, Slovenia
1. Polymer Recycling: Scope, Justificaton and Limitations.
2. ICS-UNIDO Regional Networking: Focal Points

W. Zhong, Fudan University, China
Plastics Consumption, Waste Management and Development of
Environmentally Degradable Plastics in China

R. P. Singh, National Chemistry Laboratory, India
1. R&D Activities of EDPs in India
2. Plastics Recycling Technology in India

P. Agamuthu, University of Malaya, Malaysia
The Production and Utilization of Plastics in Malaysia

R. M. Singh, Royal Nepal Academy of Science and Technology
Plastics Industries and Plastics Waste Recycling in Nepal

N. T. Quy, Inst. Of Industrial Chemistry, Vietnam
Plastics wastes in Hanoi and their Treatment

M. Ardestani National Petrochemical Co., Iran
Plastics Waste Management and EDP's Development in Iran

2) Participants

There were 138 participants attending the Woprkshop. Of these participants, 121 were local and were 19 Overseas. (see Appendix III for the list of participants)

3) Workshop Exhibitor

3 companies were to exhibit their products at the Workshop. These were:

1. Team Plas Chemical Co.,Ltd. Bangkok, Thailand. (recycle products from EPS Foam)
2. Heppe GmbH, Germany. (Starch/Chitosan biodegradable polymer)
3. Novamont S.P.A., Italy. (products made from biodegradable plastics "Mater-Bi")

Opening Ceremony:

Participants were in the opening ceremony, which was during 9.30-9.30 on 21st October. K. Suchiva, MTEC, presented organizer report. S. Miertus, ICS-UNIDO Area Director, presented welcoming Address. Congratulation Addresses were presented by C. Scaratti, UNIDO representative and R. Manara, Counsellor, Italian Embassy. Opening Remark was made by P. Bhandhubanyong, Director MTEC.

Programme:

The scientific programme of the Workshop consisted of 9 sessions. They are listed below together with the number of contributions in each session.

SESSION 1: INTRODUCTION	3 Papers
SESSION 2: PLASTICS RECYCLING 1	2 Papers
SESSION 3: DEVELOPMENT OF EDPs : PRODUCTION AND APPLICATION 1	5 Papers
SESSION 4:DEVELOPMENT OF EDPs 2: STANDARD	2 Papers
SESSION 5:COUNTRY REPORT 1	4 Papers
SESSION 6:COUNTRY REPORT 2	5 Papers
SESSION 7:DEVLOPMENT OF EDPs: PRODUCTION AND APPLICATIONS 2	2 Papers
SESSION 8:PLASTICS RECYCLING 2	2 Papers
SESSION 9:COUNTRY REPORT 3	3 Papers

The time of each presentation was 30 minutes for the lectures and 20 minutes for the country report.

Social events:

Since the conference site, Sol-twin Tower Hotel, is in the heart of Bangkok, the shopping centers, tourist attractions are all within easy reach. The following social events were organized:

Sunday, 20th October

Welcome reception for all invited speaker at Gold Teak Restaurant in Sol Twin Towers Hotel

Monday, 21st October Banquet at Ruen Thep Room/Silom Village

Tuesday, 22nd October MBK shopping center

Wednesday, 23rd October Visit Wat Phra Kaeo (Temple of the emerald Buddha) and World Trade shopping center

Assessment:

A Standard questionnaire was distributed to participants, 13 participants returned the filled questionnaire to the organizer. Summary of the returned questionnaire is given in Appendix IV.

Results and suggestions for follow up:

The Workshop was considered successful and interesting by all participants. The following follow-up activities will be implemented. A local Workshop will be organized by the National Metal and Materials Technology Center (MTEC) as a follow-up activity in January/February 2003. Private companies, relevant government agencies, and researchers from universities and research institutes will be invited to attend the Workshop. The objective of the workshop is to prepare national action plan for plastics waste management activities, emphasizing Environmentally Degradable Plastics (EDPs) and Plastics recycling.

MTEC will act as the national ICS focal point to coordinate and promote activities (e.g. Research, standards, training and pilot projects) according to the national action plan, including, in particular, coordination with the new Ministry established recently, The Ministry of Natural Resources and Environment and in cooperation with ICS-UNIDO

**Appendix I the expenses for the organization
of the Workshop**

Appendix II The program of the Workshop

Appendix III The list of participants

**Appendix IV Summary of Questionnaire
Evaluation**

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**Appendix I the expenses for the organization
of the Workshop**

Appendix I

Summary of the final budget

UNIDO Contribution	Planned in US\$	Baht
Total travel for international lecturers	12,487	547,242
accommodation meals and meal for international lecturers	2,645	116,380
TOTAL	15,132	663,622

MTEC Contribution	Planned in US\$	Baht
Fax / Telephone / Post	124	5,456
Publication of Proceedings	420	18,480
Training materials	760	33,440
Secretariat	250	11,000
Accommodation and meals for Thai Participants	2,750	121,000
Other expenses(e.g. Welcome reception, Banquet, Sight seeing for Invited Speaker)	4,880	214,720
TOTAL	9,184	404,096
TOTAL EXPENSES	24,316	1,069,904

The exchange rate at the day of receiving of the first payment (20/11/2002) Was 1 USD ~ 44 Baht

Appendix II The program of the Workshop

ICS-UNIDO INTERNATIONAL WORKSHOP
PLASTICS RECYCLING AND DEVELOPMENT OF ENVIRONMENTALLY DEGRADABLE PLASTICS
21-23 October 2002, Sol Twin Tower Hotel, Bangkok, Thailand

Organized by
National Metal and Materials Technology Center

PROGRAMME

21 October 2002

- 8.00-9.00 Registration
- 9.00-9.30 Introduction
- Organizer Report (K. Suchiva)
 - Welcoming Address (S. Miertus, ICS-UNIDO Area Director)
 - Congratulation Address (C. Scaratti, UNIDO representative)
 - Congratulation Address (R. Manara, Counsellor, Italian Embassy)
 - Opening Remark (P. Bhandhubanyong, Director MTEC)
- 9.30-10.00 S. Miertus (ICS-UNIDO Area Director)
- Introduction to the ICS-UNIDO Programs and Activities in the Area of Pure and Applied Chemistry, focussing on the Sub-program of Environmentally Degradable Plastics
- 10.00-10.30 Coffee Break
- SESSION 1: INTRODUCTION**
- Chairman: K. Suchiva**
- 10.30-11.00 E. Chiellini (Dept. of Chemistry and Industrial Chemistry, University of Pisa, and ICS-UNIDO Scientific Advisor Italy)
- Environmentally Degradable Plastics-An Overview
- 11.00-11.30 S. Wongjaroen (Wongpanit Recycling Company)
- Plastics Recycling in Asia
- 11.30-12.00 R. Pinthong (Pollution control Department)
- Policy and Legislation of Plastics Waste Treatment in Thailand
- 12.00-13.00 Lunch Break

SESSION 2: PLASTICS RECYCLING 1

Chairman: R. P. Singh

13.00-13.30 S. H. Kandill (Dept. of Materials Science, Alexandria University, Egypt)

Plastics within the Solid Waste Management Matrix

13.30-14.00 A. Krzan (National Inst. Of Chemistry, Slovenia)

Polymer Recycling: Scope, Justification and Limitations

SESSION 3: DEVELOPMENT OF EDPs 1: PRODUCTION AND APPLICATION 1

Chairman: E. Chiellini

14.00-14.30 R. Narayan (Dept. of Chemical Engineering, Michigan State University, USA.)

Biobased Polymeric Materials and Plastics, New Trends and Expectations

14.30-15.00 G. Swift (G. S. Polymer Consultants, USA)

Progress in the Design, Production and Commercialization of EDPs

15.00-15.30 **Coffee Break**

15.30-16.00 Y. H. Kim (Korea Inst. Science and Technology, Korea)

Review on Biomedical Application of Biodegradable Polymers

16.00-16.30 P. N. Lan (Polymer Center, Hanoi University of Technology, VIETNAM)

Biodegradable Films Made from LDPE and Modified rice, Cassava Starch and from LDPE and Unmodified starch using Compatibilizer

16.30-17.00 Y. Tokiwa

Microbial Degradation of Plastics

22 October 2002

SESSION 4: DEVELOPMENT OF EDPs 2: STANDARD

Chairman: G. Swift

9.00-9.30 E. Chiellini (Dept. of Chemistry and Industrial Chemistry, University of Pisa, Italy)

Standard on Plastics Waste Management in Europe including EDPs

9.30-10.00 R. Narayan (Dept. of Chemical Engineering, Michigan State University, USA.)

Standards for Environmentally Degradable Plastics & Biobased Products

10.00-10.30 **Coffee Break**

SESSION 5: COUNTRY REPORT 1

Chairman: S. Miertus

10.30-10.50 W. Zhong (Department of Macromolecular science, Fudan University, China)
Plastics Consumption, Waste Management and Development of Environmentally Degradable Plastics in China

10.50-11.10 S. H. Kandill (Dept. of Material Science, Alexandria University, Egypt)
Plastics in Egypt: A country Profile

11.10-11.30 R. P. Singh (National Chemistry Laboratory, India)
R&D Activities of EDPs in India

11.30-11.50 P. Agamuthu (University of Malaya, Malaysia)
The Production and Utilization of Plastics in Malaysia

11.50-13.00 **Lunch Break**

SESSION 6: COUNTRY REPORT 2

Chairman: P. Agamuthu

13.00-13.20 Y. H. Kim (Korea Inst. Science and Technology, Korea)
Status on Plastic Waste Treatment, Recycling and EDPs Development in Korea

13.20-13.40 M. Yusman (BPPT, Indonesia)
Current Status of Plastic Recycling and EDPs in Indonesia

13.40-14.00 R. M. Singh (Nepal)
Plastic Industries and Plastic Waste Recycling in Nepal

14.00-14.20 N. T. Quy (Inst. Of Industrial Chemistry, Vietnam)
Plastic wastes in Hanoi and their Treatment

14.20-14.40 M. Ardestani (National Petrochemical Co.,Iran)
Plastic Waste Management and EDPs Development in IRAN

14.40-15.30 **Coffee Break**

SESSION 7: DEVELOPMENT OF EDPs: PRODUCTION AND APPLICATION 2

Chairman: R. Narayan

15.30-16.00 Rapthel (Heppe Ltd., Germany)

Technology Development for the Production of Biodegradable Materials on the Base of Cassava Starch and Chitosan

16.00-16.30 G. Braunegg (Graz University of Technology, Austria)

Sustainable Polymeric Materials from Renewable Resources and Agro-industrial Waste

23 October 2002

SESSION 8: PLASTICS RECYCLING 2

Chairman: T. Leejarkpai

9.00-9.30 A. Hiranpradit and S. Atichatsrisakul (Thai EPS Recycling Group)

Recycling of EPS Foam

9.30-10.00 R. P. Singh (National Chemistry Laboratory, India)

Plastics Recycling Technology in India

10.00-10.30 **Coffee Break**

SESSION 9: COUNTRY REPORT 3

Chairman: Y. H. Kim

10.30-10.50 G. Braunegg (Graz University of Technology, Austria)

Solid Waste Management and Plastics Recycling in Austria and Europe

10.50-11.10 K. Suchiva (National Metal & Materials Technology Center, Thailand)

Development of EDPs in Thailand

11.10-11.30 **Discussion on Follow-up Activities**

11.30-12.00 **Conclusion and Recommendation**

12.00-13.00 **Lunch Break**

13.15 **Sight-seeing Visit-Wat Phra Kaeo (Temple of the Emerald Buddha)**

Appendix III The list of participants

List of Participants to ICS-UNIDO Workshop
Plastics Recycling and Development of Environmentally Degradable Plastics (TR-45-38)
21 - 23 October 2002
Sol Twin Towers Hotel, Bangkok, Thailand

No.	Name	Address
Private Company		
1	Anima Chantanasevi (F) Marketing Officer	Thai Petrochemical Industry Public Co.,Ltd. 26/56 Chan Tat Mai Rd. Tungmahamek, Sathorn Bangkok 10120 Thailand Tel : 0-2678-5050 Fax : 0-2678-5006
2	Awirut Sopaladawan (M) Engineer	Thantawan Industry Public Co., Ltd. 143-144 Soi Kangval 2, Phet Kasem Rd., Om Yai Sam Phran, Nakhon Pathom 73160 Thailand Tel : 0-2273-8333 Fax : 0-2273-8282
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4	Charoon Bhusiri (M) Senior Sales Manager	Chemical Innovation Co., Ltd. 4 Ramkhamhaeng 30, Ramkhamhaeng Rd., Huamark, Bangkok, Bangkok 10240 Thailand Tel : 0-2375-5197-200 Fax : 0-2374-6503,0-2732-1632 E-mail : charoon@elastomer-polymer.com
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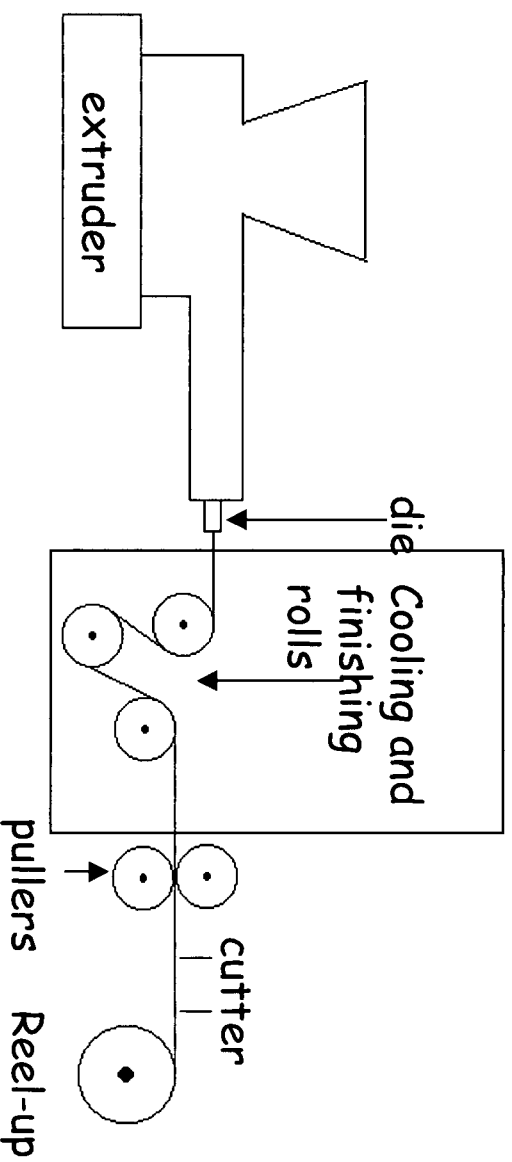
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Cooling and finishing rolls



“nip”

: the roll entry point is adjusted to a gap dimension 5-10% larger than the final sheet.

🔧 **Temperature controlled by oil or water**

: temperature of upper and middle rolls > temperature of lower roll

🔧 **Size of rolls depend on cooling time, out put rate, melt temperature**

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Summary of Registration

Private Company	41
University	35
Government Agency	22
Student	19
Lecturer	<u>21</u>
TOTAL	138

**Appendix IV Summary of Questionnaire
Evaluation**

ICS-Workshop/Training Course:

EVALUATION OF QUESTIONNAIRE (Total of 13)

A. Organization:

1. How did you obtain in formation about this workshop/course?

- From the organizers	30.8	%
- Information document from MTEC	23.1	%
- From the website of ICS - UNIDO	7.7	%
- University	7.7	%
- Others ... (friend)	7.7	%
- No comment	23.1	%

	Excellent	Very Good	Good	Fair	%
2. The information process was	7.7	61.5	30.8	0.0	%
3. The announcement and pre-course material was Describe the content of the workshop/course:	7.7	38.5	46.2	7.7	%
4. I found the scientific programme	15.4	46.2	38.5	0.0	%
4.1 Applied Lecture/Workshop	23.1	46.2	30.8	0.0	%
4.2 Use of small working groups	0.0	46.2	46.2	7.7	%
4.3 Case Studies	7.7	46.2	46.2	0.0	%
4.4 The time spent by lecturers in class and after class on specific questions/examples	7.7	46.2	38.5	7.7	%
	Balanced	Unbalanced			
4.5 Students scientific knowledge was	84.6	15.4			%

B. Duration of programme:

	Just right	Too long	Too short	%
1. Number of days	69.2	30.8	0.0	%
2. Length of working days	92.3	7.7	0.0	%

C. Training facilities & Hotel:	Excellent	Very Good	Good	Fair	
1. Lecture/Training Rooms	23.1	30.8	38.5	7.7	%
2. Breaks/refreshments	46.2	23.1	30.8	0.0	%
3. Hotel accommodation	38.5	30.8	30.8	0.0	%
4. Meals at the hotel	30.8	30.8	38.5	0.0	%

	Excellent	Very Good	Good	Fair	
D. Organizer's response to participants needs	15.4	46.2	38.5	0.0	%

E. Overall programme organization	23.1	38.5	38.5	0.0	%
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F. Would you recommend to others from your institution/ country to attend a similar activity in the future?	Yes	Maybe	No	
	84.6	7.7	7.7	%

1. Which part of the Activity did you find most useful?

- Standard on EDPs.
- Technical Information.
- Session 3 - R. Narayan.
- Biodegradable Polymers.
- EDPs and recycling business.
- Session 6 , Session 7, Session 1.
- Paper presentations & discussion.
- Development of EDPs and standard.
- Development / production & Application.
- Development of EDPs : Production and Application.

2. Which part of the activity do you think should be expanded?

- Biodegradable Polymers.
- Posters Sessions, Social Mixer.
- Session 6 - M.Yusman (BPPT,Iudouesia)
- Application of EDPs , Production of EDPs.

- Energy recovery (Thermal Recycling of Plastics).
- Development of EDPs: Production and Application.
- Development of EDPs and the research (newly) Technology.
- Paper presentations should be divided into research papers and country report
More time for research reporting.

3. Which part of the activity do you think should be dropped?

- Session 5.
- Country report.
- All are good, but should schedule more production and application.

4. Any other suggestions for future improvements to the programme?

- More of application of EDPs.
- New research & technology.
- Posters Sessions, Social Mixer.
- Getting more detail related to reduce waste.
- Plastics recycling plant : incineration; production etc.
- Support private industrialists at least pick up the local hospitality.

5. Do you think that the topics/tools you studied during the course could be used by industries in your country? If so, how? If not, why not?

- Yes, improved research proposals in wider spectrum.
- ICS-UNIDO hope/suggest to improve the program are especially for 3rd world countries.
- Use the knowledge for recycling and use the knowledge for modification of polyolefins. (PE&DP)
- Not much, because most of the topics are review and the new application and process to use are small.
- Yes, as plastics waste is increased and is difficult to get rid so it needs biodegradable plastic for reducing plastics waste problem.

6. Can you suggest any programme and future activities which ICS could pursue in order to help with the technological and scientific advancement of your country?

- Continue the same topics.
- Organize specialized workshops on (a) methodology involving plastics study.

- To exchange the technology and present the innovation or share the corporation.
- Disseminate information on recycling of plastics and EDPs to plastics manufacturers association and recycled plastic manufacturers association.
- Yes, These programmes needs ICS-UNIDO power to stressed its government more active to implement plastic waste issue due to the world to be save.

7. Do you think you have benefited from participation in this course/workshop?

If so, how? And your Institution?

- Yes, acquired lot of knowledge about EDPs.
- Yes, I learnt about the development of EDPs.
- Gain recent knowledge on recycling and plastics waste management.
- Yes, we can learn about how to solve plastics waste problem and new biodegradable plastics.
- Yes, I learned something new and relevant from the speakers. And got to know people in the field.

8. How do you intend to disseminate the information you have acquired during the activity once back in your own country?

- Have information distributed to working group.
- Copy of proceedings will be deposited in the urbane.
- I will give to the government as input positively on have government involved resiously.
- Disseminate the information to industries and organizations through associations and environmental concerned agencies.

G. Evaluation of Lectures and Speakers

	Excellent	Very Good	Good	Fair	
1. Course materials	23.1	38.5	38.5	0.0	%
2. Resident Lecture presentation	7.7	53.8	38.5	0.0	%
3. International Lecture presentation	23.1	46.2	30.8	0.0	%
4. Ability of lecturers to answer specific questions	7.7	61.5	30.8	0.0	%

Any comments :

Involved more countries for environment issues.