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Final Report

Workshop

on

"Sustainable Plastics in India and Asian Countries"

National Chemical Laboratory
Pune, India
CSIR, Government of India

14-16 December 2006

UNIDO project No. : TE/GLO/04/105
UNIDO Contract Order No. : 16001304ML/CZ

Prepared by A.J. Varma- NCL Pune

INTRODUCTION

The Workshop on ***"Sustainable Plastics in India and Asian Countries"*** held in Pune, India, was organized by ICS-UNIDO – the International Centre for Science and High Technology of the United Nations Industrial Development Organization based in Trieste, Italy, in collaboration with the National Chemical Laboratory, Pune, India.

It is well known that the production and consumption of polymeric materials for commodity and specialty plastics items have lead to several challenges to be met with respect to the management of the post-consumer plastics waste. In this respect, the development and production of environmentally friendly polymeric materials would be a desirable objective for the management of plastics waste. The new degradable plastics should replace the conventional commodity plastics in those segments in which recycling is not feasible.

Several efforts from many quarters have contributed to the public awareness for the need for environmentally degradable polymers (EDPs) in a sustainable manner. In-spite of significant scientific and technological developments, EDPs have not yet penetrated the market place due to their much higher price as compared to conventional petroleum based plastics. There are also several technology restrictions, and therefore there is an urgent need to support research and development efforts in this field. The high price of EDPs cannot be reduced unless the demand is increased. Such a market can be developed, at least in the initial stages, by tax incentives and government legislative decisions enforcing the utilization of environmentally biodegradable plastics. The introduction of degradable polymeric materials is expected to provide a competitive alternative to present solid-waste management such as burial in landfill sites, incineration with energy recovery, and mechanical or chemical recycling.

During the past decade, several industries, most notably in USA, Italy and Germany, have made rapid technological developments for producing commercially several new types of environmentally degradable polymers. Some of these are fully based on natural polymers like starch, while many others are based on blends of modified starch with synthetic aliphatic esters, polyvinyl alcohol, etc. These developments have lead to a very positive response from the public, and given renewed impetus to the scientific community. Many countries around the world, including the developing countries, are adopting strategies to promote the use of such materials in their countries such that the raw material availability is suitable to that country, in order to make the transition sustainable.

The Workshop was therefore focused on providing the state-of-the-art information on all scientific, technological, and status of standards in the field of environmentally degradable polymers, and in obtaining country reports of the status of developments in the individual participating countries as well as reports on the ICS-UNIDO initiatives in progress for some of the countries such as Thailand and Iran, and using this feedback to introduce other relevant programs in the region.

ORGANIZATION

The Workshop on ***"Sustainable Plastics in India and Asian Countries"*** held in Pune, India, was jointly organized by ICS-UNIDO – the International Centre for Science and High Technology of the United Nations Industrial Development Organization based in Trieste, Italy, in collaboration with the National Chemical Laboratory, Pune, India. The following bodies took responsibility for the scientific and organizational aspects of the event:

ORGANIZERS:

Local Organizer:

The National Chemical Laboratory (NCL), India is a research, development and consulting organization with a focus on chemistry and chemical engineering. It has a successful record of research partnership with industry. It is a constituent laboratory of The Council of Scientific and Industrial Research (CSIR) of India, under which there are 38 laboratories in different areas of research and development. NCL is one of CSIR's largest research laboratories.

The following persons took the responsibility on the local organizer's side:

Dr.A.J.Varma, Deputy Director, National Chemical Laboratory, Polymer Science and Engineering Division, Pune, was the convener of the Workshop.

Dr.D.V.Gokhale, Senior Scientist, Biochemical Sciences Division of the National Chemical Laboratory, was the secretary, who carried out many organizational activities

Dr.K.B.Bastawde, Senior Scientist, Biochemical Sciences Division of the National Chemical Laboratory, acted as the Treasurer, and handled the financial aspects.

ICS-UNIDO:

S. Miertus, Area Chief
E. Chiellini, ICS-UNIDO Scientific Advisor
Pure and Applied Chemistry
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34012 Trieste, Italy

DATE AND SITE

The Workshop was held from December 14-16, 2006 in Pune, Maharashtra State, India. The accommodation was arranged in hotels and guest houses near the venue, whereas the lectures were arranged in an appropriate lecture room with all facilities for power point projection, audio visual displays, etc.

PARTICIPATION

Representatives of academia, national laboratories, and industry from 7 Asian countries – India, Malaysia, Nepal, Thailand, Iran, Kuwait, Indonesia, - participated in the

Workshop. Several scientists and students from the host institute and neighboring institutes also participated resulting in a total of 52 participants (see Annex. II).
Invited lecturers came also from Japan, Poland, Italy, Germany.

WORKSHOP MATERIALS:

Each participant and lecturer obtained Workshop materials. The invitation containing the main objectives of the forum and some details on the organization was distributed by e-mail or regular mail. At the registration and at the end of the workshop, the following materials were given to all of the registered participants:

1. Final Agenda of the workshop with book of abstracts
2. Office supplies with conference material.

PROGRAMME

There were 20 lectures in all -

- 8 key lectures
- 8 country report lectures
- 4 academic lectures

The keynote lectures were related to

- Goals and objectives of ICS-UNIDO and international programme initiatives
- Country reports from Asian countries
- Plastics waste management issues
- New methods of synthesis of biodegradable polymers
- Industrial developments
- Standards and test methods

These lectures were followed by a round table conference to summarize the salient features of the outcome of the Workshop and to discuss the possible follow-up actions.

The final agenda is presented Annex. I

OBJECTIVES

The main objective of the Workshop was focused on the following aspects:

- To build awareness and institutional capacities of the selected countries in Asia on the status and on the most recent developments in the field,
- Presentation and discussion of the role of standardization in EDPs and testing degradability,
- Presentation of country reports from participating Asian countries on the status of development of EDPs,
- To stimulate international research and knowledge transfer and enhance international co-operation in this new field,

- To contribute in the identification of qualified centres and experts to be considered within ICS-UNIDO network on EDPs

FINAL DISCUSSION AND PROPOSALS FOR FOLLOW UP ACTIVITIES

The workshop ended with a round table discussion for further developing this field and enhancing cooperation between various participating countries. The Workshop provided an excellent forum to discus the issues and possible solutions to the production of environmentally degradable polymers in a sustainable manner, as well as making it cost effective to be able to displace the conventional non-degradable plastics in particular sectors of applications.

The following proposal on the future initiatives were presented and discussed:

- Set up of informal network of international scientists will be finalized in the year 2007 to exchange regular information on EDPs technologies.
- The participation of Institutions and Companies from third countries in RTD proposal specifically focused on Plastic Waste Management and Environmentally Degradable Plastics will be supported by EC provided the proposal will be eligible.
- It was agreed to prepare a specific collaborative programme on standards on EDPs and setting up standardization laboratories under the guidance of ICS-UNIDO.
- A concept of collaborative projects has been discussed and agreed especially on the development of new EDPs using renewable feedstocks (cellulose).

For the concepts/ideas of possible collaboration projects see also Annex III.

ACHIEVED RESULTS

- Improved awareness of about 50 academic and industrial experts from India and Asian countries with the exchange of knowledge and updated information on various aspects of biodegradable polymers
- Experimental protocols in specialized laboratories available in different countries for the academic and industrial attendees were made available
- Potential partner institutions for future actions were identified to strengthen the ICS network.
- Collaborative links for developing joint proposals were established and concept of possible future initiatives presented and discussed. In this respect a proposal focused on Production of Environmentally Degradable Plastics from Renewable Resources is under preparation within the 7FP program launched by EU. India & Thailand will be involved together with partners from EU countries.

Financial Part

FUNDING

The planned contribution from ICS-UNIDO amounted to 20,000.00 €; of this an amount of 15,000.00 € has already been transferred by ICS-UNIDO to the local organizer. The real expenditure from ICS-UNIDO budget was of € 12,994.95. The unspent balance of € 2,005,05 will be transferred back to ICS-UNIDO, as detailed below. (1 Euro = Rs.58.7 approx.)

ITEMS TO BE COVERED WITH THE ICS-UNIDO BUDGET

ICS–UNIDO Real Expenditure	**In INR**	**In Euros**
Contribution of ICS-UNIDO Euro 15,000 (INR 8,80,824)		
Travel of 11 invited international lecturers	4,93,318.00	8404.05
Travel of 5 invited national participants	64,079.00	1091.63
Daily Subsistence Allowance (ad hoc DSA) for 12 international lecturers, (INR 2500 each)	30,000.00	511.07
Daily Subsistence Allowance (ad hoc DSA) for 5 invited national participants and lecturers		00.00
Airport transfers : Mumbai – Pune - Mumbai	58,411.00	995.07
Lunch, dinner & Coffee breaks	1,16,997.00	1993.13
Sub-Total ICS-UNIDO Expenditure	**7,62,805.00**	**12994.95€**
Contributions of the hosting institution INR 3,97,740 (approx. Euro 6775.79) Monetary contributions of the hosting institution (and other co-sponsoring organizations)		
Presentation hardware, memento, workshop materials	1,12,842.00	1922.35
Payment for accommodation of participants	1,45,846.00	2484.59
Conference dinner on 15.12.2006	55,650.00	948.04
Educational visit to city of Pune and local transport charges	26,336.00	448.65
Room, Personnel, postal charges & organizational and miscellaneous expenses	57,066.00	972.16
Sub-Total Local Organizing Contribution	**3,97,740.00**	**6775.79**
GRAND TOTAL (ICS contribution + Local contribution)		**14979.82 €**

DETAILS OF CALCULATIONS -

ITEMS TO BE COVERED WITH THE ICS-UNIDO BUDGET

Note: The exchange rate applied (58.70 INR for 1 €) is the official exchange rate of State Bank of India the day advanced payment from ICS UNIDO was deposited into the Bank Account.

No.	Items description	Amount (INR)	Amount (Euro)
1	International Travel plus DSA of Dr. M. Ardestani	33652.00	573.28
2	International Travel plus DSA of Dr. R.M. Singh	19969.00	340.18
3	International Travel plus DSA of Dr. K. Suchiva	36053.00	614.20
4	International Travel plus DSA of Dr. K. Habeeb	39524.00	673.32
5	International Travel plus DSA of Dr. S. Hemjinda	22913.00	390.35
6	International Travel plus DSA of Dr. P. Agamuthu	37203.00	633.78
7	International Travel plus DSA of Dr. H. Takagi	57531.00	980.08
8	International Travel plus DSA of Dr. M. Kozlowski	56513.00	962.74
9	International Travel plus DSA Dr. M. Kowalchuk	56513.00	962.74
10	International Travel plus DSA of Dr. A. Sujito	42359.00	721.63
11	International Travel plus DSA of Dr. E. Chiellini	118588.00	2020.23
12	Hononarium of Dr. K. Moraweitz	2500.00	42.59
13	National Travel of Dr. A. Ray	11830.00	201.53
14	National Travel of Dr. A. Pandey	23368.00	398.10
15	National Travel of Dr. J. Shanker	3442.00	58.63
16	National Travel of Dr. A. Prasad	12650.00	215.50
17	National Travel of Dr. B.R. Sharma	12789.00	217.87
18	Mumbai-Pune-Mumbai car travel of 11 international and 2 national speakers invited speakers (Dr. M. Ardestani, Dr. K. Suchiva, Dr. K. Habeeb, Dr. S. Hemjinda, Dr. P. Agamuthu, Dr. H. Takagi, Dr. M. Kozlowski, Dr. M. Kowalchuk, Dr. A. Sujito, Dr. E. Chiellini, Dr. Katerina Moraweitz, Dr. A. Pandey, Dr. B.R. Sharma.	58411.00	995.07
19	Lunch, dinner & Coffee breaks (1 x 3days lunch, 1dinner & 2 x 3 days coffee for 70 participants)	116997.00	1993.13
20	**Total**	**762805.00**	**12994.95**
21	**Total amount remaining (will be sent back to ICS-UNIDO)**	**118019**	

The balance of INR 118019 will be converted to Euros and sent back to ICS-UNIDO after deducting bank charges (approx. Euro 2000).

Annexes

Annex I

Agenda

ICS-UNIDO Workshop on "Sustainable Plastics in India and Asian Countries" 14-16 December 2006

Thursday, 14 December 2006

11:00 - 13:00	Registration of participants
13.00 – 14.00	***Lunch Break***

Opening Session

14:00 - 14:30	Inauguration, Welcome Addresses *(S. Sivaram, Director NCL, Pune; S. Miertus, ICS-UNIDO Chief of Area, Italy; E..Chiellini, ICS-UNIDO and University of Pisa, Italy; A. J. Varma, NCL, Pune)*
14.30 – 15.00	Goals and Programs of UNIDO-ICS, Activities of the ICS Area of Pure and Applied Chemistry with a focus on the EDP sub-programme *(S. Miertus - ICS-UNIDO Chief of Area, Trieste, Italy)*
15.00 – 16.00	Keynote Address : An Overview of Sustainable Plastics *(E..Chiellini, ICS-UNIDO and University of Pisa, Italy)*
16:00 - 16:30	***Coffee Break***

Session one
EDP State-of the-Art and Trends in EDP and EDP Related Technologies (Chairman Prof.E.Chiellini)

16.30 – 17.00	Recent developments in environmentally degradable plastics : Anionic ring-opening polymerization for biodegradable aliphatic polyesters of controlled structure, properties and function *(M.Kowalczuk, Polish Academy of Sciences, Poland)*
17.00 – 17.30	Issues in medical plastics waste management *(A. Ray, IIT Delhi, India)*
17.30 – 18.00	Plastics for resource conservation and sustainable development *(U.Saroop, Reliance Industries, Mumbai, India)*
19.30 - 21.30	***Dinner***

Friday, 15 December 2006

Session 2
EDP's and their promotion
(Chairman Prof.E.Chiellini)

10:00 - 10:40	Environment-Friendly "Green" Composites and Their Research Trend in Japan *(H.Takagi, University of Tokushima, Japan)*
10:40 - 11:20	Industrial Development of EDP's *(K.Moraweitz, BIOS, Germany)*
11:20 - 11:50	***Coffee Break***
11:50 - 12:20	Recycling of plastics and plastics waste management *(M.Kozlowski, Wroclaw Technical University, Poland)*
12:20 - 12:50	Biopolymers : answer to the problem of plastics *(V.Rangaswamy, Reliance, Mumbai, India)*
13:20 - 14:20	***Lunch Break***

Session 3
National Status Reports (Chairman Prof. S. Miertus)

14:20 - 14:40	Sustainable Plastics in Thailand : Status report and cooperative initiatives with ICS-UNIDO *(K.Suchiva, Mahidol University, Bangkok, Thailand)*
14:40 - 15.00	ICS-UNIDO cooperative programme on EDPs with Iran *(M. Ardestani, National Petrochemical Co.,Iran)*
15.00 – 15.20	Plastic Industries and plastic recycling in Nepal *(R.M.Singh, Royal Nepal Academy of Science & Technology, Nepal)*
15.20 – 15.40	Plastics industry and plastic waste management in Malaysia *(P.Agamuthu, University of Malaya, Malaysia)*
15.40 – 16.00	Status of Sustainable EDP's in India *(A.J.Varma, NCL, India)*
16.00 – 16.30	***Coffeee Break***

17.00 – 17.30 Biodegradation of Commodity Plastics based on Polyolefins *(R.P.Singh, NCL, Pune, India)*

17.30 – 1800 Lactic acid and Polylactic acid from sugarcane juice *(S.Nene, NCL, Pune, India)*

19.30 – 21.30 ***Dinner***

Saturday, 16 December 2006

Session 4
Natural Polymers, Biotechnological Developments
(Chairman Dr.S.Sivaram)

10.00 – 10.30 Overview of the Current Indian Efforts for Sustainable Materials, and Relevant Programs of CSIR *(S.Sivaram, NCL, Pune)*

10.30 – 11.00 Lactic acid monomer: Production, application and biodegradation *(A.Pandey, RRL, Trivandrum, India)*

11.00 – 11.30 ***Coffee Break***

11.30 – 12.30 Concepts related to Bioplastics and its role in Biodegradability and National and International Standards (R.Narayan, Michigan State University, USA)

12.30 – 13.00 Standards and Testing of EDP's *(S.Hemjinda, National Metal and Materials Technology Center, Thailand)*

13.00 – 14.00 ***Lunch***

Session 5
Round Table Discussions
(Chairman Prof.E.Chiellini / S.Sivaram)

14.00 – 15.00 Summary of Discussions and recommendations

15.00 – 15.30 ***Coffee Break***

15.30 – 18.30 Visits to NCL facilities and Biotechnology and Information Parks, Pune

Annex II
List of participants with contact details

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Annex III

Ideas/concepts discussed during the final session of the Workshop in December 2006 for possible promotion as a follow up

1. A large number of presentations at the Workshop dealt with the subject of use of renewable resource based polymers as an alternative to petroleum based polymers. This showed recognition of the immense importance of this subject to various participating countries, who are grappling with the issues of sustainability, prevention of environmental pollution, waste disposal problems, and preventing greenhouse gases

2. The applications expected range from "green composites" to "flexible packaging materials", to the use of biotechnology for producing monomers like lactic acid which lead to biodegradable polymers

3. The major component of such products are expected to be renewable resources such as cellulosic, lignocellulosic, starch, and their chemical modifications.

4. A significant contribution towards the target of
   - reducing greenhouse gases,
   - addressing waste disposal problems (compostability, environmentally compatible),
   - and sustainability issues, is expected also expected.

5. It was agreed that cooperation amongst various participating countries in a project that encompasses these objectives, and makes use of the specific expertise of each participant, would be a desirable outcome.

6. Materials based on such renewable resources for packaging applications, having adequate mechanical strength, moldability, biodegradability, moisture resistance and having anti-microbila properties, in particular, found favor from many participants.