Indian Centre for Plastics in the Environment

Eco-Echoes

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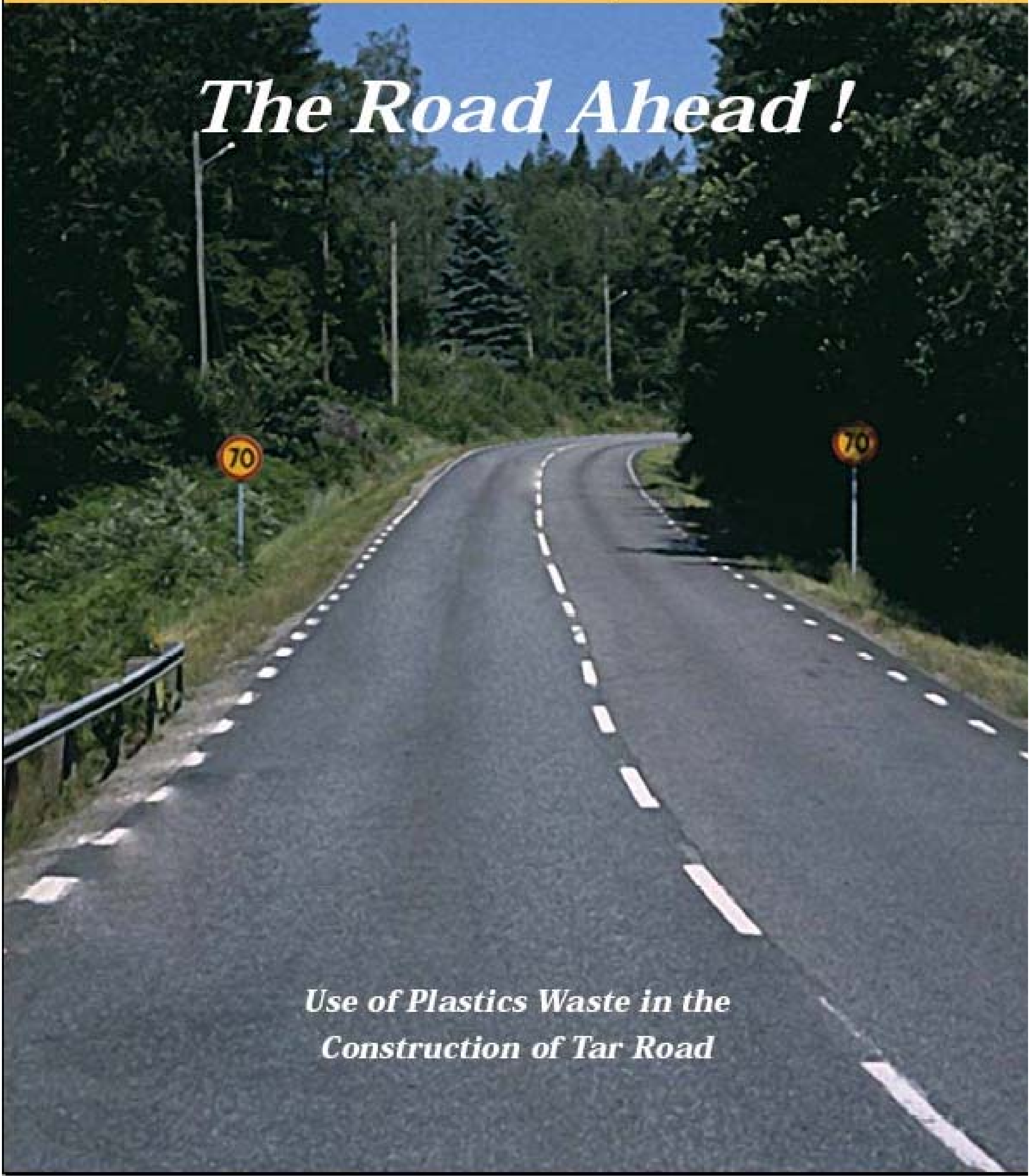

The Road Ahead !

Use of Plastics Waste in the Construction of Tar Road

In this Issue

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Readers are welcome to send their suggestions, contributions, articles, case studies, and new developments for publication in the Newsletter to the ICPE address.

EVENTS

The No. 1 Trade Fair for Plastics and Rubber – Worldwide

K 2004

20-27 October, 2004
Düsseldorf, Germany

K is the world's largest and leading trade fair for plastics and rubber industries and is held every 3 years. About 2,900 exhibitors from more than 50 nations will be showcasing their machinery, products and services at K 2004.

For information, contact:
E-mail:
k-online@messe-dusseldorf.de
Website: www9.k-online.de

IndiaChem 2004

3rd International Exhibition & Conference
3-5 November, 2004
NSE Complex, Mumbai

For details contact:
www.indiachem2004.com

Plastvision India 2004

6th National Exhibition & Seminar
23-27 December, 2004
NSE Complex, Mumbai

For details contact:
www.aipma.net

Asia's biggest and one of the largest fairs in the world of Plastics

PLASTINDIA 2006

6th International Plastics Exhibition & Conference
9-14 February, 2006
Pragati Maidan, New Delhi

Plastindia 2006 is the most awaited event for product sourcing, technology exchange and joint venture.

Concurrent with the Exhibition, International Buyer Seller Meet will be scheduled.

The Plastindia Awards for encouraging and recognising significant contribution by Indian companies to the Plastics Industry for developing innovative products, will continue to be a feature in Plastindia 2006.

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Use of Plastics Waste in the Construction of Tar Road

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Excerpts from the paper submitted for Seminar on Integrated Development of Rural and Arterial Road Network for Socio-Economic Growth. This project was co-sponsored by ICPE.

Introduction

Bitumen is an useful binder for road construction. Different grades of bitumen like 30/40, 60/70 and 80/100 are available on the basis of their penetration values. The steady increase in high traffic intensity in terms of commercial vehicles, and the significant variation in daily and seasonal temperature demand improved road characteristics. Any improvement in the property of the binder is *the need of the hour.*

Elastomers like natural rubber, crumb rubber, SBR, etc., as well as Plastomeric substances like Polyethylene, Ethylene Vinyl Acetate and Ethylene Butyl Acrylates are mixed with bitumen to modify the properties. Modified Bitumen possesses better quality.

Today the availability of the waste plastics is enormous, as the plastic materials have become part and parcel of daily life. They either get mixed with Municipal Solid Waste and/or thrown over land area. If not recycled, their present disposal is either by **land filling** or by **incineration**. Both the processes have certain impact on the environment. Under this circumstance, an alternate use for the waste plastics is also *the need of the hour.*

Thiner polythene/polypropylene carry bags are the most abundantly disposed of wastes, which do not attract the attending rag pickers for collection for onward recycling, for lesser value.

Again, these polythene/polypropylene bags are easily compatible with bitumen at specified conditions.

The waste polymer bitumen blend can be prepared and a study of the properties can throw more light on their use for road laying.

Understanding plastics

The most used plastics/polymer materials are polyethylene, polypropylene, polystyrene and polyvinyl chloride. Almost 90% of the polymeric materials are made up of either polyethylene or polypropylene or polystyrene.

Around 130-140°C they get softened without releasing any gaseous products (Table – 1).

Extraction Procedure of Toxicity (EPT) – 5% of Acetic acid solution.

It is to be noted that when PVC is incinerated (>700°C), it releases carbon, and gases like CO, CO_2, Cl_2, etc. In the presence of oxygen, chlorine, carbon and metals like copper and around 350°C it may produce gases like Dioxins (the Toxic gases) .

Table – 1 : Thermal Behaviour of Polymer

Polymer	Solubility		Softening Temp. range in Deg.C	Products reported	Decomposition Temp. range in Deg.C	Products reported	Ignition temp. range in Deg. C	Products reported
	Water	EPT						
PE	Nil	Nil	100-120	No gas	270-350	CH_4, C_2H_6	>700	CO,CO_2
PP	Nil	Nil	140 - 160	No gas	270-300	C_2H_6	>700	CO,CO_2
PS	Nil	Nil	110-140	No gas	300-350	C_6H_6	>700	CO,CO_2
PVC	Nil	Nil	200-220	HCl	320-350	C_2H_6, HCl	>700	CO,CO_2, Cl_2 & HCl

Disposal of plastics

The present day disposal of plastic waste, especially Municipal Solid Waste containing plastics, is carried out by 1. **Land filling** and 2. **Incineration**.

Land filling is a process in which the waste materials are buried in a specific area, away from the city. This process is purely temporary. This may result in (1) affecting water recharge, (2) reducing soil microbial activity, (3) clogging the drainage and (4) water line clogging. Such clogging may result in the production of gases like methane, which affects Green House effect. Above all, land availability for filling is also a problem.

Incineration is normally carried out above 700°C. Incineration of polymers like PE, PP, PS produces gases like CO, CO_2, etc. and these gases cause global warming, air pollution, monsoon failure, etc. If PVC is mixed with the waste, it may result in the production of HCl, Cl_2 and sometime Dioxin, the poisonous gas.

Modified Bitumens

Addition of natural or synthetic polymers to bitumens is known to impart enhanced service properties. By adding small amounts of polymers to bitumen, the life span of the road pavement may be considerably increased. The purpose of bitumen modification using polymers is to achieve desired engineering properties such as increased shear modulus and reduced plastic flow at high temperatures and/or increased resistance to thermal fracture at low temperatures.

Homopolymers, like high and low density polyethylene and polypropylene, as well as random and block copolymers, like ethylene-vinyl acetate, ethylene/propylene, styrene-b-butadiene-b-styrene and styrene-b-ethylene-co butylene-b-styrene, have been used as bitumen modifiers.

However, the major obstacle to widespread usage of polymer-modified bitumen in paving practice has been their tendency towards gross phase separation under quiescent conditions at elevated temperatures. A precise study on processing conditions of binders and polymeric additives selection are, thus required.

Moreover, incompatibility, unstabilisation of emulsions, higher cost of polymer and cumbersome procedure of the preparation of the mix add to the complexity of the process.

Reuse of Waste Plastics

Plastics – as Binder and Modifier

Waste plastics (polythene carry bags, etc.) on heating softens at around 130°C. A study using thermo gravimetric analysis has shown that there is no gas evolution in the temperature range of 130-180°C. Moreover the softened plastics have a binding property. Hence, the molten plastics materials can be used as a binder and/or they can be mixed with binder like bitumen to enhance their binding property. This may be a good modifier for the bitumen, used for road construction.

Study on Waste Plastics for Road Construction:

Determination of solubility of polymer in bitumen.

The waste polymers such as polyethylene (as sheets), polypropylene (sheets; film) and polystyrene (thermocole) are soluble to the extent of 1 to 2% of the bitumen.

It was observed that we need to characterise the two types: 1) waste plastics-bitumen blend containing <2% and 2) the mix containing >2%.

Samples were used to carry out the following tests, namely:

1. Softening Point, 2. Penetration Value, 3. Flash & Fire Point, and 4. Ductility Test.

Determination of softening point:
It is observed that the softening point increases by the addition of polymer to the bitumen. The influence over the softening point is depended on the chemical nature of the polymer added.

Penetration Value:
The increase in the percentage of polymer decreases the penetration value. This shows that the addition of polymer increases the hardness of the bitumen.

Ductility:
Data shows that the ductility increases by the addition of polymer to bitumen.

The increase in the ductility value may be explained as follows. The long polymer molecules when mixed hot, physically interlock the material and this may help to reduce cracking at the surface.

Flash and fire point
The study of flash and fire points of the polymer-bitumen blend helps to understand the inflammability nature of the blend.

Characterisation of Waste Plastics-Bitumen-Aggregate mix for flexible Pavement:
The utility of the Waste Plastics-Bitumen-Aggregate mix for

flexible pavement construction is characterised by studying
1) Stripping value, and
2) Marshall stability value of the mix.

Method – I

Soluble region (<2% plastics) waste

Stripping value
Waste plastics are dissolved in bitumen (2% PE) and the blend is coated over aggregate. It is tested by immersing in water. Even after 72 hrs., there is no stripping showing increased resistance to water. This shows that the blend has better resistance towards water. This may be due to better binding property of the polymer-bitumen blend.

Marshall Test:
The Marshall Stability Values were determined for the waste polymer bitumen blend having the percentage of maximum 2%.

Marshal Stability Value

Percentage of Waste Polymer	Marshall Stability Value in kg
0	1100
1	1600
1.5	1680
2	1780

The study shows that waste plastic-bitumen blend has higher strength compared to pure bitumen, whose value is approx. 1100 kg.

Note: The percentage of polymer added is always with respect to the weight of bitumen used.

Addition of waste plastics 10% – *(for Illustration only)*
Wt. of Aggregate: 1200 gms
Wt. of Bitumen: 60 gms
Wt. of Waste Plastics: 0.6 gms

Method – II:

Modified process (Higher percentage region)
Alternate method was innovated to find an effective way of using higher percentage of waste plastics-bitumen mix. In this method, initially the aggregates were heated to around 170°C. Then the plastic wastes, in the form of small pieces (passing 4.75 mm sieve – normally with a thickness of 60 micron and below) were added to the heated aggregate. This has enabled to give an uniform coating of plastics waste over the aggregates. To this hot plastics coated aggregates, the hot bitumen was added. An uniformly coated mix was obtained. This was used for carrying tests: (1) Stripping Test, and (2) Marshall Test.

1) *Stripping Test:*
The aggregate was coated with waste plastics with a known percentage and then the bitumen is coated at hot condition. The waste plastic-bitumen-aggregate mix was immersed in water. Even after 96 hrs., there was no stripping. This again shows that the waste plastic-bitumen coated mix has good resistance towards water. This may be due to (1) Increased binding of the waste-plastics-bitumen blend, and (2) Coating of polymer (a non-wetting material) over the aggregate.

2) *Marshall Test:*
Effect of addition of waste plastics (Table – 2).

It is observed that the addition of waste plastics (PE) increases the Marshall Stability Value.

It is observed that the Marshall Stability Value obtained is generally much higher than for the pure bitumen mix. It is also observed that the addition of waste plastics reduces the need of bitumen and the addition of lower percentage of bitumen with waste plastics blend shows much higher Marshall Stability Value. It is also helping to reduce the quantity of bitumen to the extent of 10% to 15%.

Effect of Variation of Polymer content with the variation of bitumen
The study of the effect of both the variation of waste plastics content and the bitumen content in the waste plastics-bitumen-aggregate mixture was carried out and Marshall values are given in Table-3.

It is observed that the addition of waste plastic increases the Marshall Stability Value to a fairly high value. It is also observed that the addition of 10% waste plastics gives higher value at the optimum percentage of bitumen (4.6%). Higher percentage of waste plastics, though give higher Marshall Stability Value, they need increased percentage of bitumen. In general, it may also be concluded that this method is the best suited process for the use of higher percentage of plastics waste and for higher performance of the flexible pavement.

Table -2 : Marshall Stability Value

% of Binder Content	Percentage of Waste Polymer	Marshall Stability Value in kg
4.6	0	1150
4.6	5	2010
4.6	10	2540

Hence it may be inferred on the basis of Marshall Stability Value that the 10% blend of waste plastics is an optimum percentage for road construction, considering the cost factor and the consumption of bitumen.

Results and discussion

It is observed that the polymer-blended bitumen has better properties regarding Softening Point, Penetration Point, Ductility, Stripping Value and Marshall Stability Value. Hence the blend can be used for laying flexible pavement.

Method I:
The blending was tried by directly mixing the shredded polymer with hot bitumen at 160°C. Here the mixing of higher percentage of polymer was rather difficult due to large difference in the viscosity of the molten polymer and that of bitumen. A powerful mechanical stirring was needed to ensure effective mixing to get a better blend. This also needed the addition of stabilizers and proper cooling, yet the blend was not stable and the maximum percentage that can be added was around 2%. Only test roads were laid using this method.

Method II:
A novel technique is developed to use higher percentage of waste plastics in road construction and using this technique an alternate method is being used.

In this method, the waste polymer was added on the hot aggregate (170°C). The polymer was coated over the aggregate. Here the spreading was easy. The hot aggregate was coated with polymer uniformly. Then the bitumen was added. The mixing of bitumen with polymer was taking place at the surface of the aggregate. The temperature was around 155-163°C. Both the polymer and bitumen were in the liquid state. With the increase of surface area of contact, the mixing of polymer film with bitumen film would be better as both are similar in chemical nature and are in liquid state. And thus a better blend is formed. This blend is having better binding property, which is observed from its properties like Marshall Stability Value, etc.

The formation of fairly uniform coating is also observed from the experimental results (Table – 3). This technique was used for the construction of road using Mini Hot Mix plant.

On the basis of above reasoning various aspects regarding the Polymer-Bitumen Road are also being discussed below:

Stripping Test
Most of the aggregates used in road construction have greater affinity for water due to inherent wetting nature of the aggregate than for bitumen. This results in the penetration of water between aggregate and bitumen layer. Thus bitumen film is often stripped off the aggregates in the presence of water. This stripping results in pot-hole formation.

When polymer is coated over aggregate, the coating reduces its affinity for water due to non-wetting nature of the polymer and this resists stripping. Moreover the polymer-bitumen blend is having higher binding property too. This also resists stripping and hence pot-hole formation is very much reduced.

Leaching Test
Polymers are not soluble in water or acids and even in most of the organic solvents. The Toxicity test solution is 5% acetic acid. The polymer waste is tested with this 5% acetic acid solution (EPT) and it is observed that there is no dissolution of polymer. Therefore it may be concluded that polymer will not leach out of the bitumen layer, even after laying the road using waste plastics-bitumen-aggregate mix.

Pot-hole Formation
Stagnation of water over bituminous surface results in stripping of bitumen. This subsequently results in pot-hole formation. In the case of polymer bitumen blend, the penetration of water is not much. Hence the pot-holes are not formed easily. This is observed in the various test

Table - 3 : Effect of Variation of Polymer content with the variation of bitumen

% of Bitumen	% of Polymer	Marshall Value
4.6	0	1150
4.6	5	2010
4.6	10	2540
4.6	15	2440
4.6	20	2300
5.0	15	2670
5.0	20	2040
5.5	20	1830

stretches laid by the author at different places.

Dioxin Formation

The fear about the formation of Dioxin, the toxic compound, during the heating of polymers is always in the mind of people.

In the process of the preparation of polymer-bitumen aggregate mix, the temperature used is only ≈ 170°C and no chlorine or copper is present in the system. Moreover, the polymer materials used are polyethylene, polypropylene and are polystyrene only and we do not use polyvinyl chloride. Hence, there is no possibility of presence of chlorine in the system. Hence Dioxin does not form during the use of waste polymer for road construction. So it is a **safe disposal of waste polymers.**

Effect of Bleeding

The increase in the softening point shows that there will be less bleeding during summer. Bleeding accounts, on one side, increased friction for the moving vehicles and on the other side, if it rains, the bleedings accounts for the slippery condition. Both these adverse conditions are much reduced by polymer-bitumen blend.

Special Aspects

- The whole process is very simple.
- It needs no new machinery.
- The technology is also very simple.
- The waste plastics available in the surrounding area can be used then and there.
- Moreover crumb rubber required 180°C whereas 60/70 grade bitumen needs 160°C only. This accounts for fuel conservation.

Roads – already laid: Using waste polymer bitumen aggregate mix, roads have been laid at different places at Tamil Nadu using different surface area and different composition. The conditions of roads are under observation and they are performing well till today.

A scheme for laying Waste Plastics – Tar road in rural area for 1000 km was launched on 16th July, 2003 at Namakkal by the Honourable Chief Minister of Tamil Nadu Dr. J. Jayalalitha.

Significance and Utilization Potential

- The polymer bitumen blend is a better binder compared to plain bitumen.
- The blend has increased Softening Point and decreased Penetration Value with a suitable ductility.
- When used for road construction it can withstand higher temperature. Hence it is suitable for tropical regions.
- It has decreased Penetration Value. Hence its load carrying capacity is increased.
- The blend with aggregate has no Stripping Value. So it can resist the effect of water.
- The Marshall Stability Value is high.
- The bitumen required can be reduced depending upon the % of polymer added. It is a good saving too.

If 1 ton of Crumb is used, the cost is Rs. 13,000.

If 1 ton 60/70 grade bitumen is used, the cost is Rs.10,000.

4% of bitumen is saved. Hence the cost is Rs. 9,600.

100 kg of waste plastics costs Rs. 500.

Total cost Rs. 10,100.

The quality is definitely better than CRMB with the saving of Rs. 2,500/ton

Moreover CRMB requires 180°C whereas 60-70 grade bitumen requires 160°C. This helps fuel conservation.

- The waste polymer, otherwise causing disposal problem by way of **land filling** and **incineration** has a better place to stay.
- The operation temperature is below 160-170°C.
- No toxic gas is produced. Dioxin is not formed during this process.
- Disposal of waste plastic will no longer be a problem.
- The binding properties of polymer also improve the strength of mastic flooring.
- The use of waste plastics on the road has helped to provide better place for burying the plastic waste without causing disposal problem. At the same time, a better road is also constructed. It also helps to avoid the general disposal technique of waste plastics namely land-filling and the incineration, which have certain burden on ecology.
- By spraying the waste polymer pieces (passing 4.5 mm) the mixing is done. The process is simple and easy.

Degradable Plastics – Global & Domestic Scenario

Mr. P. V. Narayanan,
Advisor-ICPE
&
Mr. T. K. Bandopadhyay,
Technical Manager-ICPE

Seminar on "Degradable Additives – Solution to Plastics Waste Disposal"

ICPE sponsored a half day seminar on –"Degradable Additives – Solutions to Plastics Waste Disposal' on June 11, 2004, at Mumbai. The seminar was organised by Organisation of Plastics Processors of India, at Indian Merchants' Chamber.

The participants in the seminar were from different fields – Government Bodies, Plastics / Polymer Manufacturers, Masterbatch Manufacturers, Plastics Processors and large consumers of Plastics.

A paper on – "Global & Domestic Scenario Pertaining to Degradable Plastics" was jointly prepared by Mr. P. V. Narayanan, Advisor-ICPE and Mr. T. K. Bandopadhyay, Technical Manager-ICPE, and was presented during the seminar by Mr. P. V. Narayanan.

All the papers presented during the seminar have been uploaded in ICPE website.

Introduction

Plastics due to their versatility have become the essential ingredients to provide a quality to life. Nearly 50% of plastics is con- dients to provide a quality to life. Nearly 50% of plastics is con-sumed by the packaging and construction industry. Other major consumption is by consumer goods (16%), electrical (8%), automobile (7%) and agriculture (5%). Per capita consumption of plastics has been steadily on the increase, obviously leading to waste. They are both recoverable and non-recoverable, the latter being more difficult to deal with. They also create relatively more environmental problem. The desirable approach is to degrade them in the natural environmental conditions and within a reasonable time frame. Factors that affect biodegradation include physico chemical properties, microbiological parameters, primary properties, and material processing. The degradation of plastics in the environment can undergo abiotic or biotic degradation or remain as it is. Photo oxidation, hydrolysis, oxidation, and photolysis influence abiotic degradation which is partial and forms fragments. Biotic degradation is influenced by environmen- forms fragments. Biotic degradation is influenced by environmen-tal conditions and presence of microbes – type and quantum wise. The degradation could be into smaller fragments or complete mineralisation as molecules of methane, Co_2, water, salt and biomass. Effective and efficient biodegradation is effective through consortium of appropriate microorganisms, conducive environmental conditions, that help microbial growth and vulnerability of substrate for microbial attack.

A review of common test methods used for assessing biodegradability of plastics materials are illustrated in table below.

Most plastics do not decompose in the environment and hence Most plastics do not decompose in the environment and hence can be ignored. Therefore biode-

Test parameter	Measurement / Indicator	Microbial System
Microbial growth	Microscopic observation determination of turbidity protein or phospholipic content	Pure or mixed culture
Polymer Utilisation	Weight loss, turbidity CO_2 evolution	Pure, Mixed culture, Natural ecosystem or Cell-free enzyme extract
Changes in polymer characteristics	Change in Molecular weight by GPC, tensile strength and percentage elongation by NMR/FTIR	Pure culture
Microbial activities	Gas production or Oxygen consumption	Sewage sludge, compost, pure/ mixed culture or sample from natural ecosystem
Clear Zone	Turbidometric	Pure culture

gradable plastics that get microbially decomposed have attracted much attention globally as they become part of the natural ecosystem and thus cause no eco problem. Biodegradable plastics have preference more in single use/ one shot packaging systems. Biodegradable plastics should thus be end use performance oriented and biodegrade conforming to appropriate waste management infrastructure into environmentally compatible constituents such as CO_2, H_2O, and compost. Significantly they leave no persistent or toxic residue. The degradability is generally affected by the chemical bonding, functional group, structural unit, microstructure, side chain, molecular weight, melting point and crystallinity.

Environmentally degradable plastics find innumerable opportunities. They include fast food, and one way packaging, and personal hygiene products which are compostable without separation. The other typical examples include mulchable agricultural films and fishing gears. The prospective markets for biodegradable polymer includes, wraps for various consumer goods, viz., medicines, agricultural, forestry and fishery products, blending stocks, plasticisers, lubricants, pesticides, detergents and chemical agents for fibres & papers. The optimal use of degradable polymers necessitates the formulation of appropriate characteristics with degradation time as specifics. Thus controlled periods of biodegradation ranging from months to years depending on application could provide a better choice in as much as a hundred per cent biodegradability within a period may not be the need.

Factors below could be the lead in considering in converting a polymer degradable for a given application.

- Process of degradation need to be established particularly when exposed to varying climatic conditions such as packaging. They should also conform to FDA and related regulations.
- Photo degradability of litters depends on exposure to UV radiation.
- Biodegradability is relevant only to landfill as process needs burial and moisture.
- Degradation components should be clearly characterised to specify toxicity and environmental effects.
- Degradable plastics might cost more due to special handling needs and hence cost effectiveness. Additional cost due to restrictions on distribution, e.g., Photo degradables for northern latitudes and southern latitudes as well as seasonal variations.
- Photo oxidation may lead to build up of high concentration of carbonyl compounds with molecular weight reduction. Such MW reduction is not uniform. Photo oxidation also imparts hydrophilicity to the initially hydrophobic LDPE based degradables.
- Homogeneous and heterogeneous polymer blends can be recycled in the presence of a small concentration of non-oxidised degradables. Controlling the recycling conditions should help to minimise the changes in the polymer properties.

Degradable Plastics

A plastic material designed to undergo a significant change in its chemical structure under specific environmental condition with specified time period resulting in loss of properties compared to the starting properties.

Biodegradable Plastics

A degradable plastic material in which the degradation results from the action of naturally occurring micro-organisms such as bacteria, fungi, algae.

Seminar in progress

Section of Participants

Major Producers of Biodegradable Polymers (2001)

Company Name	Plant Capacity (1000T/year)	Type	Trade Name
U.S.A.			
Cargil Dow			
i. (Minnesota)	8.0	PLA	ECOPLA
ii. (Nebraska)	140.0	PLA	ECOPLA
Union Carbide (West Virginia)	4.5	PCL	TONE
Eastman Chemical (Tennessee)	1.4	Co-polyester	EASTER BIO
Chronopol Golden Technologies Co. Inc. (Colorado)	0.9	PLA	HEPLON™
Uni-Starch Industries (Illinois)	<0.5	Starch Copolymer	STARKORE™
Planet Polymer Technologies (California)	0.5	Starch-based	Environ Plastic
DuPont (Tennessee)	90.0	PET-based	Biomax®
Bio Plastics Inc. (Michigan)	<0.2	Starch/PCL	ENVAR
Ecossata (New York)	N.A	Starch-based	Novon
EUROPE			
Bayer (Belgium)	10.0	Polyester amide	BAK
Novamont (Italy)	8.0	Starch-based	Master-Bi
Bitech (Germany)	1.0	Starch-based	Bioflex
ICI/Monsanto (England)	1.0	Starch-based	Biopol™
Eastman Chemcial (England)	Shared facility	Co-polyester	EASTER BIO
Slovay Interox	N.A.	PCL	CAPA
JAPAN			
Daicel Chemical (Hiroshina Prefecture)	3.0	PCL	Celgreen
Show High Polymer			
i. Tatsuno (Hyogo Prefecture)	3.0	Starch-based	Bionolle
ii. Takasaki (Gumma Prefecture)	0.01	Starch-based	Bionolle
Chisso (Chila Prefecture)	2.0	Starch-based	Novon
Dainippon Ink & Chemicals	3.0	PLA	N.A.
Shimadzu (Shiga Prefecture)	1.0	PLA	Lacty
Mitsui Chemical (Fuknoka Prefecture)	0.5	PLA	Lacea
KOREA			
S K Chemicals	2.0		SKY GREEN
DSK Corporation	1.0		GREEN POL

Photodegradable Plastics

A degradable plastic material in which the degradation results from the action of natural day-light.

Pears

Definition as per ASTM D 6400 - 99

(i) The product should be converted into CO_2, water and biomass at the same rate similar to that of craft paper and other compostable materials - Biodegrade.

(ii) The product should not be visible and need not be screened after composting - Disintegrate.

(iii) No harmful product/emission be formed.

World Consumption of Plastics
• 150 Mn Tonnes

PE, PS, PP, PET constitute more than $^2/_3$rd of total plastics consumption. Out of this, about 50% quantity goes for packaging applications, most of which are for shorter life span. (Major applications of PVC are for long term use).

Disposal problems of these one time/short life plastics packaging materials created the need for development of Biodegradable Plastics.

(However, one of the earliest Biodegradable Plastic items developed was the peg / mount of Golf Ball in the USA).

Manufacturers of Degradable Plastics

Initial Manufacturers were mostly from the USA & Canada.

Warner - Lambart - USA
Amko - USA
Air Products - USA
Agrico Chemical Company – USA
Nova Corporation – Canada

European Companies
Novomont, Italy
Cabot Europe Ltd., France
Exxon Chemicals, Belgium
Rohn-Poulene Chemie, Belgium
Hoechst, Germany

On a later stage, Cargil DOW-USA and DuPont – USA became the major manufacturers of Biodegradable Plastics.

Installed capacity in 2001, worldwide, stood at about 141,000 MT.

Another 1,40,000 MT Capacity was added by Cargil Dow in 2002/3.

Projection of capacity in 2005 is 500,000 MT.

Major Processes

1. Starch Based Polymers – Poly Caprolactone
2. Poly Lactic Acid Polymer
3. Polyvinyl Alcohol
4. PHBV - by Bacterial Fermentation
5. Aliphatic / Aromatic Co-polymer

Poly Lactic Acid-based products are most common.

Indian Scenario

Some Indian Companies, either by themselves, or in technical collaboration with some foreign companies, are offering either the Biodegradable Plastic Films or the Master Batches, which can be blended with virgin polymer, to produce Biodegradable/ Degradable Plastics Films:

Following companies reported to be the suppliers:

1. Shivalik Ago-Poly Products Ltd., Paravanoo, H.P. (Technology from NRDC)
2. Degradable Polymer Technologies, Pune (Indigenous Technology)
3. G. Tech Associates, Yamuna Nagar (imports M/B from USA)
4. Biodegradable Plastics, Gurgaon, U.P. (with Technical Assistance from Germany)
5. Preeti Polymers (in collaboration with Symphony Plastics, U.K.)
6. Plasti Blends: Offers Master Batch

Issues faced by Indigenous Industries

 # No Indian Standard at present (A Committee has been formed by BIS).

 # Testing of the film / product as per ASTM methods.

– No Indian Recognised Laboratory offers service for commercial testing.

General Issues

1. Biodegradation takes at least 3 months under suitable conditions.
Is it acceptable that any Biodegradable Food Wastes should be wrapped in such BD Film for disposal and not allow the food waste to biodegrade within this period?

2. Mixing of the Biodegradable and Non-biodegradable Plastics in the waste/recycle stream may render the high volume non-biodegradable plastics unuseful for targeted recycled products.

3. At what cost?

Race Horses are onto a Winner with Plastic Horse Shoes

Horse-shoes designed for the forelegs of race horses from Polyamide 6,6 and TPE (Thermoplastic Elastomer) and containing a small steel strip, insert-moulded, called "JAMEG SPRINTER" offers more comforts than the traditional steel or aluminium horse-shoes. The new horse-shoe is adhered to horse's hoof with an Acrylic adhesive of-

fering freedom from nailing. This is bound to increase the number of races in which the horse can compete. Nylon imparts flexibility by making the horse-shoes an integral part of their legs while TPE provides better grip and shock-absorption. Plastics eliminate chances of badly broken feet and reduced injury to a fallen rider.

Disposal problems of these one time/short life plastics packaging materials created the need for development of Biodegradable Plastics.

(However, one of the earliest Biodegradable Plastic items developed was the peg / mount of Golf Ball in the USA).

Manufacturers of Degradable Plastics

Initial Manufacturers were mostly from the USA & Canada.

Warner - Lambart - USA
Amko - USA
Air Products - USA
Agrico Chemical Company – USA
Nova Corporation – Canada

European Companies
Novomont, Italy
Cabot Europe Ltd., France
Exxon Chemicals, Belgium
Rohn-Poulene Chemie, Belgium
Hoechst, Germany

On a later stage, Cargil DOW-USA and DuPont – USA became the major manufacturers of Biodegradable Plastics.

Installed capacity in 2001, worldwide, stood at about 141,000 MT.

Another 1,40,000 MT Capacity was added by Cargil Dow in 2002/3.

Projection of capacity in 2005 is 500,000 MT.

Major Processes

1. Starch Based Polymers – Poly Caprolactone
2. Poly Lactic Acid Polymer
3. Polyvinyl Alcohol
4. PHBV - by Bacterial Fermentation
5. Aliphatic / Aromatic Co-polymer

Poly Lactic Acid-based products are most common.

Indian Scenario

Some Indian Companies, either by themselves, or in technical collaboration with some foreign companies, are offering either the Biodegradable Plastic Films or the Master Batches, which can be blended with virgin polymer, to produce Biodegradable/ Degradable Plastics Films:

Following companies reported to be the suppliers:

1. Shivalik Ago-Poly Products Ltd., Paravanoo, H.P. (Technology from NRDC)
2. Degradable Polymer Technologies, Pune (Indigenous Technology)
3. G. Tech Associates, Yamuna Nagar (imports M/B from USA)
4. Biodegradable Plastics, Gurgaon, U.P. (with Technical Assistance from Germany)
5. Preeti Polymers (in collaboration with Symphony Plastics, U.K.)
6. Plasti Blends: Offers Master Batch

Issues faced by Indigenous Industries

 # No Indian Standard at present (A Committee has been formed by BIS).

 # Testing of the film / product as per ASTM methods.

– No Indian Recognised Laboratory offers service for commercial testing.

General Issues

1. **Biodegradation takes at least 3 months under suitable conditions.**
   Is it acceptable that any Biodegradable Food Wastes should be wrapped in such BD Film for disposal and not allow the food waste to biodegrade within this period?
2. **Mixing of the Biodegradable and Non-biodegradable Plastics in the waste/recycle stream may render the high volume non-biodegradable plastics unuseful for targeted recycled products.**
3. **At what cost?**

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fering freedom from nailing. This is bound to increase the number of races in which the horse can compete. Nylon imparts flexibility by making the horse-shoes an integral part of their legs while TPE provides better grip and shock-absorption. Plastics eliminate chances of badly broken feet and reduced injury to a fallen rider.

Use of Recycled Plastics for Food Packaging

Mr. A. S. Athalye,
Technology Transfer Pvt. Ltd., Mumbai

There has been growing interest to use, at least to the minimum possible extent, the recycled plastics in packaging of food products, a single largest outlet for the plastics in packaging.

The acceptability of such materials is related to the inhibitions with respect to:

- Foul odour
- Migration of undesirable
- Dirt/other contamination
- Colour change
- Thermal degradation

Very realistically, clean scrap of in-house recycling is routine in many processes for manufacturing plastics packaging and is normally not considered as recycled scrap at all. Examples of such are sprues and runners of moulded parts, flash and pinch-off of blow moulded products, side trims of extruded sheets, punched sheet of thermoformed/products of films rejected due to gauge variation or unacceptable winding, There is no scope to use adhesive laminates, printed pouches, etc. as well multiplayer films.

If the recycled scrap is being brought from open markets and/ or originated from the unknown source, it can have a doubtful purity and therefore, the acceptability. It may not be easy to identify the polymer by normal means available in the Q.C. Lab. Thus, some scrap may be suitable for recycling into food packaging and other material may not.

Generally, when one refers to the use of recycled plastics for any end –use application, it generally means the post consumer scrap such as pet bottles carry bags, HDPE containers, woven socks, thermoformed disposables, household products like buckets, bowls, mugs, milk pouches, etc. With, this type of recycling, the degree of uncertainity about the purity of the recycled material increases dramatically,

First, the material may be a mixture of resin of different grades and / or from different suppliers. LDPE for example, has over fifty variants though for a common man, it is just a 'POLY'.

It is also not possible to know or identify if the grades are those approved for food contact applications. There is no practical way to guarantee that none of the collected containers, for example, have been subject to misuse by the consumer such as emptied container used for storing a pesticide powder.

Thus the aim in providing for safe use of post-consumer recycled plastics waste in food packaging is to determine a combination of conditions that provide a reasonable degree of certainity that there will be no adverse health hazards from such use. The most important criterion that any migration of substance from the package into food packed in it will be at levels, which are within the acceptable daily intake for specific substances for that polymer, type of food, use conditions or that the levels are low enough to fall below the threshold of regulations.

The Health Authority's position is that it is the responsibility of the manufacturer to assure that the polymers and additives used are those approved by the BIS for food contact application and has to issue a certificate to that effect, if the manufacturer has no problem using the recycled material from open market.

In some overseas countries, the dilemma was solved by putting into place a procedure by which a manufacturer could be issued a formal "letter of no objection' from FDA for a given process and/ or end- use of recycled plastics in food packaging. If a manufacturer seeks a letter of no objection, they must provide to FDA evidence that the process/application involved will provide the required degree of certainity that the contaminants that may be present in the recycled stream will not migrate to contained food products in amounts that are potentially harmful.

Approved or more precisely the 'non-objected' ways of using recycled plastics in foods packaging is in three types:

1. Feedstock recycling, where a chemical process is used to break the polymer down to low molecular weight compounds,

Recycling Strategies

1. Create a public awareness campaign on a major scale to develop a positive attitude towards plastics usage, disposal and recycling.
2. Recycling should be accorded 'Industry Status' and incentives to attract organised sector participation.
3. Unless economic benefits are seen, investors would not be interested with social objectives only.
4. Participation from organised sector would encourage technology sourcing and systems from countries, where they are already proven.
5. Cost-effective solutions and value added recycled products would create a niche market for recycled products.
6. Consistant quality recycled products would enhance the image and acceptability of the recycled product.

Courtesy: Mr. Vipin Mital, Flex Industries, Ghaziabad.

Plastics Waste (K+)

		2006-07
Total plastics	:	8054
Process waste	:	161
Post consumer waste	:	3624 (45%)

Courtesy: Shriram Institute of Research Paper presented in National Seminar in Plastics Waste Management.

Polymer Recycling

The polymer recycling usually involves:

- Segregation
- Washing
- Shredding
- Extruding
- Testing density, melt index, etc., for correct further use

Uses of Recyclate

1. In place of virgin material

Ecological considerations
Consumer demand/acceptance
Advertising argument
Rising disposal cost (production waste)
Price
Legislation/Subsidies

→ **Properties close to those of new material**

2. In place of wood/concrete

Advantages because of plastic-specific properties (weight, mouldability, durability)
Low system cost
Legislation/Subsidies

→ **Designed for long term applications**

(Source: CIBA)

which are purified and then repolymerised – generally for PET and HDPE for which the process is approved already.

2. Use of recycled PET and PS is acceptable to produce trays, cups, troughs, etc., where chances of migration are not great.
3. Use of recycled material as an sandwich layer in 3-layer and as an non-contact layer in 2 layer co-extruded construction is the safest and the most accepted.

Manufacturer's responsibility

Both the end-user and the packaging material supplier has to ensure that the material supplied and being used is safe for food contact application and will not cause any health hazard.

Scenario

A few thousand tons of plastics waste in the form of films, bottles , thermoformed products, woven sacks, etc. is being recycled and also consumed. Unfortunately, the end-user, today, is more price conscious that the health safety and has been making several compromises and most often, even getting through without any hassels. This is mainly because the related laws are not being very strictly imposed. In the USA for example the regulators both at the State as well as Federal level, have taken action significant to plastics packaging materials selection, primary manufacture, recycled content requirement and the polymer coding. As of today, we have adopted the polymer coding only, which only helps a recycler to identify and segregate to avoid mixing of different polymers.

With the increase in exports of processed foods and also increasing awareness of consumers at home, a protective legislation as well as self imposed discipline by the end-user as well as packaging material supplier has become need of the day.

I have been advocating for a long time to have branded recycled materials with a nomenclature and a property data sheet just as a virgin polymer from a raw material supplier. The data sheet should also include the suggested processing parameters and the end-use applications. This would certainly mean some additional cost but its insignificant and certainly worth it to ensure safety of the consumer.

References

1. Plastics Packaging – Hanser
2. Handbook of Packaging – A. S. Athalye

Gujarat State Plastic Manufacturers Association (GSPMA)

Office bearers for the year 2004-05:

President	:	Mr. Amrit Patel
Vice-Presidents	:	Mr. Yogendrabhai Patel
		Mr. Rajiv Raval
Hon. Secretary	:	Mr. Shailesh Patel
Hon. Jt. Secretary	:	Mr. Harshit Shah
Hon. Treasurer	:	Mr. Rashmikant Mehta
Ex-officio	:	Mr. Vishnu Patel

International News

Used Carton Collection Expands

The Tetra Pak Philippines - used carton collection program has now expanded to one of Manila's largest shopping malls. The Ayala Foundation, Ayala Property Management Inc, Ayala Center and Tetra Pak Philippines launched the Tetra Pak Carton Collection and Recycling Programme at the Ayala Center shopping mall on March 17, with representatives from various government agencies and non-government organisations.

Collection bins were handed over to Ayala Bus Terminal, Ayala MRT station and three supermarkets to serve as drop-off points for post-consumer Tetra Pak cartons. Department of Environment Secretary Elisea Gozun congratulated Tetra Pak and its partners for this recycling project. "I would like to encourage the public to collect used Tetra Pak cartons and bring them to the drop-off points so that these will be recycled into composite boards."

The cartons are recycled into composite boards by Trans-National Paper Corporation. These composite boards are water resistant, durable, sound proof, formaldehyde free and can be sawn, molded and screwed like other building boards.

Raw material for composite board manufacture at the Trans-National Paper Corporation plant is collected partly through Manila schools participating in the 'Tetra Pak Care and Share Program'. This program, begun in 2002, has placed recycling bins in selected schools, where students deposit their used cartons – from home as well as those they use at school.

In 2003, 45 schools collected empty, flattened cartons throughout the school year. The program concluded with a prize distribution to the schools with the best collection record, during Tetra Pak Philippines' 'environment day' in December. Nine Manila schools shared cash and other rewards worth a total of PhP 290,000 (approx. USD 5200), in the prize distribution. Also, each of the more 'affluent' schools that took part 'adopted' a much less privileged school – and those schools 'adopted' by the top four winning schools also received another PHP 1,40,000 (approx. USD 2,500) in rewards, comprising cash or useful items made from recycled material. Collection in these schools resumed last January 2004.

(Source: www.tetrapak.com)

Recycling Pact

Waste Busters, a Lahore-based environmental Non Governmental Organisation (NGO), and Tetra Pak Pakistan have signed a Memorandum of Understanding (MoU) to recycle 30 million post-consumer Tetra Pak cartons in the current year. According to the MoU, Waste Busters will use all its resources to collect PVW from Lahore and other cities to reach a target of 30 million cartons by the end of 2004. It will also collect PCW from households, scavengers, schools and factories of Tetra Pak's customers to achieve the target.

This MoU marks the beginning of the second phase of Tetra Pak's recycling campaign "Proud Pakistanis Recycle", launched last year in Lahore on World Environment Day 2003. Under this campaign over 10 million cartons were recycled in Lahore. The objective of the campaign is to provide clean and healthy living environment to the people of Pakistan, and to promote small and medium enterprises in the recycling industry for employment generation and poverty alleviation.

(Source: www.tetrapak.com)

Project Gets a Boost

The Philippine Government has given a boost to San Miguel's USD 118.8 million manufacturing and recycling project. Other than packaging, the Board of Investments (BOI) included medical tourism, environmental services and petrochemicals in its IPP plan. These activities are given fiscal and non fiscal incentives such as income tax holidays.

The San Miguel project, which had earlier been rejected by the BOI after it failed to meet the threshold for recycled components, could qualify for incentives due to the petro-chemical industry that covers upstream such as the naphtha cracker and midstream activities such as the polymerisation plant that produces PE and PP. Plastics bottle manufacturers are opposing the plan of the BOI to extend full fiscal incentives to the project, since the recycled components of it would only account for 10% of the final product, with 90% still being sourced from virgin resin.

(Source: Flexo & Gravure Asia, 2-2004)

Presentation on Environmental Projects Undertaken by ICPE

Hotel Tunga International, Andheri, Mumbai – April 20, 2004

In a Meeting organised by Organisation of Plastics Processors of India, Shri Vijay Merchant, Member -GC, ICPE, made a presentation on the Solid Waste Management Projects undertaken by ICPE at Matheran and other selected Wards of Mumbai.

Besides OPPI Members, the Meeting was attended by some NGO's engaged in similar activities.

Representatives of some NGOs agreed that they had a wrong perception about Plastics, which were removed after the meeting.

Training Programme on Environmental Law in India – Rules and Regulations

Organised by Engineering Staff College of India at Hyderabad – 25-27 June, 2004

ICPE attended the programme where more than 40 organisations and Government departments participated.

All the relevant Environmental Laws in India – related to Plastics and Solid Waste Management were selected from the publication and uploaded in ICPE website for ready reference.

National Workshop of ENVIS Centres and Nodes

Organised by Ministry of Environment and Forests at Dehradun – 25-27 June, 2004

ICPE participated in the 3-Day-National workshop, attended by about 70 of the 85 ENVIS Centres and Nodes of all over country selected by the Ministry to act as nodal points of Environment Information System in different fields. The Workshop was held at Wildlife Institute of India, Dehradun.

The World Bank Assisted Programme on "Environmental Management Capacity Building Technical Assistance (EMCBTA)" was scheduled for the period July 01, 2002 to June 30, 2004. MoEF has decided to fund some of the Centres/Nodes so that the Environmental Information System is continued for the benefit of the country. ICPE has been selected as one of such Centre/Node, which will receive the fund from the Ministry.

During the course of the Workshop, relevant queries on the position of Plastics in the Environment were replied. The issues were:

1. PVC and Dioxin
2. Phthalate Plasticisers and Cancer
3. The real reason of various State Government's banning the use of Polyethylene Carry Bags less than 40 micron or in the case of H.P., less than 70 micron thickness.

Group photograph of Envis Nodes Coordinators across the country. Also seen in the picture are senior level officials of MoEF: ❶ Mr. Sudhir Mital, Jt. Secretary; ❷ Mrs. Meena Gupta, Addl. Secretary; ❸ Mr. S. Singsit, Director, WII; ❹ Dr. (Mrs.) Indrani Chandrashekharan, Director (EI).


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