ICPE
INDIAN CENTRE FOR PLASTICS IN THE ENVIRONMENT

Envis Eco-Echoes

Management of Plastics, Polymer wastes and Bio-polymers and impact of Plastics on the Eco-system

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Name of the ENVIS Centre

INDIAN CENTRE FOR PLASTICS IN THE ENVIRONMENT

Olympus House, 2nd Floor, 25, Raghunath Dadaji Street, Fort, Mumbai - 400 001.

Tel.: +91 22 4002 2491, 2261 7137 / 7165

Fax: 2261 7168

E-mail: icpe@vsnl.net, icpe@envis.nic.in

Websites

www.icpeenvis.nic.in

www.icpenviro.org

• • •

1009, Vijaya Building, 10th Floor, 17 Barakhamba Road, New Delhi - 110 001.

Tel.: 011 4359 6329 • Telefax: 011 2332 6376

E-mail: icpedelhi@airtelmail.in

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Area of Activity

Capacity Enhancement Programme on Management of Plastics, Polymer Waste and Bio-Polymers, Impact of Plastics on Eco-System

Editorial

Since the discovery of man-made plastics in the Nineteenth Century and its continuous development thereafter for various applications, systematic and successful efforts have been made to improve the stability and quality of plastics towards higher mechanical, chemical and resistance properties to make the end products more durable. Over a period of time, difficulty in the management of waste created especially by some types of haphazardly discarded plastics products, especially some types of packaging materials after their use, made the scientists to search for a type of plastics, which would degrade in the environment thus avoiding the waste management problem by these types of short lifespan plastics products.

Many new issues, however, were raised on these types of degradable plastics. The main concern was that the new type of plastics should not create a new challenge / burden to the environment. Although the search for Biodegradable Plastics began in the late Seventies / early Eighties and although many major Petrochemicals Raw Material Manufacturers worldwide including those from the USA, Canada, Europe and Japan had set up small plants for manufacturing such plastics, total consumption of Biodegradable Plastics have reached a figure around Half a Million Tons only, compared to about 200 Million Tons of Conventional Plastics.

Questions have been raised by the policy makers and general mass on the basic issue – whether there should be specific effort for popularizing the use of Biodegradable Plastics? Many organisations world over expressed their opinions on the subject. In this edition of ENVIS Eco-Echoes Newsletter we bring to you a Position Paper on Biodegradable Plastics by ICPE. A brief opinion of one of the internationally known experts of Indian origin in the field, who is involved in the manufacture of this type of plastics raw material in the USA for special use, is also included. Given in the Data Sheet are brief details of major manufacturers of Biodegradable Plastics in the world.

Recycling of mixed / co-mingled plastics for manufacturing of useful products remained a challenge for long time. Energy recovery and conversion to fuel options were already successfully implemented in India. Manufacturing facilities of plastics lumber from mixed plastics had already started in Europe, about a decade ago. However, cost of such plants are in the higher range in the Indian context.

Now a machinery manufacturer in India is offering commercial plant for manufacturing plastics lumber as replacement of wooden planks for making school benches at an affordable cost. A brief on the development has been included in this issue

Comments may be forwarded to ICPE ENVIS Centre.

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Biodegradable Plastics – ICPE Position

Introduction

Synthetic polymers have become very versatile and useful material for the modern world. Since the discovery of man-made polymers, continuous and systematic efforts have been made to make polymers more stable, mechanically stronger and chemically resistant and environmentally safe and durable. The constituents of synthetic polymers include – Plastics, Man-made Fibers, Elastomers or more commonly known as Rubbers and Bio-polymers. This paper mostly deals with Plastics and Bio-polymers, though the basic chemistry applies to all polymers.

The attributes like light weight yet strong, least energy consumption and minimum emission of pollutants in the air and water during production, inert characteristics, excellent water resistance and barrier properties, excellent insulation and dielectric characteristics, ease of fabrication into variety of shapes and structures – to name a few, have all made plastics not only a material of choice for an array of applications, use of plastics has become essential in every sphere of our modern life. The long life of plastics products has added to the convenience. Plastics have almost replaced materials such as metal, glass, wood, paper, fiber, ceramics etc. in packaging, automobiles, building construction, biomedical fields, electronics, electrical equipments, appliances, furniture, pipes and heavy industrial equipments. In a nutshell, from agriculture to transport and from aerospace to food packaging, the use of plastics has become an integral part of our modern daily living.

However, for certain applications, the properties of plastics are desired minus its long life. In fact, the products are required to degrade after a specific period of time. The 'Golf Tee' used to hold the golf ball, was one of the earliest applications of biodegradable plastics. The necessity of the natural degradation of the material was felt when many Tees remained uncollected due to traceability problem and were left in the field that created safety problem for the future golfers. Fasteners used to trap animals in the forests were also in the early development category. However the major emphasis for the development of biodegradable plastics was for natural degradation of some kind of plastic products after its intended use, which otherwise created problem for recycling or disposal. Polymers which were initially developed to withstand the mechanical and environmental abuse during their useful life are required to be degraded shortly after their intended life span. One example of such application is 'mulch film' for agricultural use. After the production of the crop, it is not easy to wrap up the film from the entire field in a clean condition. The soil contamination with the film makes recycling a difficult proposition. Earlier the farmers used to burn the film after use. This was a cause of concern to the authorities (Japan). Although the authority had banned burning of agricultural film, still there was a tendency among the farmers for disposing the film this way for many years. Hence, the farmer was comfortable when biodegradable agricultural film was developed, which used to get converted into manure and gets mixed with the soil – biodegraded / composted, after the yield of the crop. This gives triple benefit to the farmer - saving on water during the cultivation (the basic purpose of mulching), avoiding the effort to remove the film after use and increasing the fertility of the soil by composting the film with the soil. This was a great challenge to the polymer scientists. One of the most important desired applications of biodegradable polymer is in the medical field like suture, which becomes a part of the human body after healing the wound.

Issues

Main issues are:

1. Definition
2. Are biodegradable plastics really environment friendly?
3. Do biodegradable plastics disappear or degrade in the environment or in the landfill on its own?
4. Recycling or Degradation / Composting - which should be given more priority?
5. Which application areas should be developed / encouraged for using biodegradable plastics?
6. How to judge in the market place – whether a plastic product is really biodegradable or not?
7. Technology status and availability at reasonable cost
8. Role of Government – should it encourage Recycling or Biodegradation?

Claims

Though some of the world leaders in the field of polymer manufacture have started developing and manufacturing degradable polymers, which are compostable and are considered as biodegradable polymers - safe for the environment, there are some other manufacturers,

who claim to have developed a type of product called "Oxo-degradable Plastics", which self destructs itself when it is left in the open environment. They claim that the products will automatically Oxo-degrade in the backyard or in the field and vanish in the presence of oxygen, relieving the civic authorities and the residents of the plastics waste littering problem.

Some other manufacturers are offering products made by physical blending of a master batch of ingredients with conventional synthetic polymers and claim the product as truly biodegradable.

Both these manufacturers are trying to market their products in the applications like – Plastic Carry Bags and similar applications.

The traditional manufacturers of compostable plastics, which include the largest companies of USA, Europe and Japan, through their respective associations, have raised their concern on such claims.

International Biodegradable Polymers Association & Working Groups (IBAW) expressed their concern on such claims attracting the attention of the authorities and general users that whenever a packaging product is placed on the market as "degradable", conformance with the requirements of 94/62/EC is to be assessed through the use of EN 13432 (in Europe). IBWA declares that no PE additive product, like the "Oxo-degradable" plastics, has yet been shown to comply with EN 13432. It adds that so called "Oxo-biodegradable" additives pose several concerns regarding safety and ecotoxicity. These additives are based on ionic metals that trigger PE fragmentation. Some metal compounds used in these products are classified and labelled under the EU Directive 67/548/EEC on Dangerous Substances as causing adverse effects on humans and the environment. For instance, cobalt Co (II) has been found in concentrations higher than 4,000 mg/kg in "Oxo-biodegradable" additives. At such high concentrations these materials are considered harmful if released into the environment, and are regulated at the workplace of plastic manufacturers and converters, since metal fumes might be released through dust or under heating. During the fragmentation process however, regulated metals may be liberated into the environment with the consequence of adding (eco) toxic persistent and bio accumulative CMR substances (Carcinogenic, Mutagenic, toxic to Reproduction).

"Oxo-biodegradable" PE products have been described as a solution to littering problems, as after trashing they are supposedly decompose in the natural environment. De facto such a concept promotes littering and endangers organic recovery schemes which are built up to promote sustainability.

The manufacturer of Oxo-degradable plastics material rejects such allegations and justifies that such product degrades by a two-stage process. The first phase is abiotic oxidation in which the formulation breaks the molecular chains within the polymer. When the molecular weight has reduced to 40,000 Dal tons or less, the material is no longer a plastic, but a material which can be bio-assimilated by naturally-occurring micro-organisms in the same way as nature's wastes. At the end of the process there is only water, Co_2, biomass and trace-elements. However the manufacturer does not give specific time frame for its degradation but assures that the product would degrade quicker than the natural materials like leaves or straw and more quickly than ordinary plastics.

IBAW however points out that it has not been certified in line with widely-used EU standard EN 13432 for "packaging recoverable through composting and biodegradation" (which closely resembles a U.S. standard, ASTM-6400 on compostable plastics).

The Oxo-biodegradable Plastics Association, an industry grouping, doesn't believe EN 13432 - particularly the requirement of compostability - is appropriate to their products, and has pushed for a review.

ICPE POSITION

On - Definition

Bureau of Indian Standard (BIS) has accepted the concept and definition of Compostable Plastics as provided in ISO: 17088:2008, as Biodegradable Plastics. ICPE accepts this.

On - environment friendliness of biodegradable plastics (compostable plastics) and

On - whether compostable plastics disappear or degrade in the environment or in the landfill on its own?

It is evident that the degradation / composting process releases carbon dioxide in aerobic condition and methane and carbon dioxide in anaerobic condition. Both the situations are not desirable as both carbon dioxide and methane are greenhouse gases. Plastics recycling do not create such situation.

The Oxo-degradable plastics release more harmful agents during disintegration. Moreover, a molecular- weight range of 40, 000, after disintegration, is quite high and is well within the category of High Polymer. The disintegrated polymer powder remains in the soil.

However, after considering overall assessment of specific application / s, when it is absolutely necessary that a product has to be designed with biodegradable plastic material, it is reasonable to agree that the compostable plastics, as defined in ISO 17088: 2008 could be used in principle for such applications.

It is important here that appropriate facility for composting should be available in working condition and the disposal sites / landfill sites should be composting the waste as per laid down norm. In the Indian context municipality landfill sites are generally not equipped with this infrastructure of mechanical composting. For Agricultural Mulch film or Plant seeding bags (nursery bags), Golf Tees – which are supposed to get mixed with the soil at the site of use, this criterion is not necessary.

This is important because even if a product is certified as 'Compostable' as per designated ISO / BIS specifications, the same would not get composted in the disposal site if it is not appropriately treated.

Compostable Plastics do not degrade or disappear into the soil on its own. It will remain in the open environment if not treated appropriately.

On - Recycling or Composting - which should be given more priority?

Recycling should be given priority as a part of resource management. Material Recycling means replenishment of the resource. Plastics products, which can be mechanically recycled for producing products for non-food contact applications, save use of virgin raw materials thus saving resources. Composting generates greenhouse gases – carbon dioxide and methane, mechanical recycling does not. Although compostable plastics are generally made from renewable natural resources, still it is a debatable issue whether the farming activity should be principally restricted for human (and animal) food requirement. This debate is on for manufacturing biodiesel also.

Moreover, while making products from biodegradable or non-biodegradable plastics, lot of energy is required. In case of non-biodegradable products, the waste is recycled to augment the material (virgin) requirement and hence energy and resource is saved. In case of biodegradable plastics, the products are degraded / composted necessitating fresh input for product manufacture. The energy and resource is lost.

Biodegradable plastics also creates problem of mixing up with non-biodegradable plastics waste and normal recycling process chain is disturbed.

Multi-layer plastics waste, which are generally difficult for mechanical recycling except manufacturing compressed boards etc, can also be treated for recovery of energy like co-processing in the cement kiln, replacing fossil fuel. Industrial fuel also can be generated from all plastics waste including multi-layer plastics waste.

In case of biodegradable plastics, such retrieval of recycled product or energy is not possible. Hence, biodegradable plastics may be developed and used only for applications, which cannot be recycled or recovered.

A Life Cycle Analysis, which computes the overall impact of a product on the environment, helps in taking any final decision on this issue.

On - Which application areas should be developed / encouraged for using biodegradable plastics?

Plastics products, which are difficult for mechanical recycling or from which energy cannot be recovered, can be manufactured with compostable plastics. Following are the recommended products, which may be made out of compostable / biodegradable plastics:

Agricultural Mulch Film, Nursery Bags, Garbage Bags / Wet Waste Disposal Bags, Special Food Wraps, Coating on Paper/Jute/Textile, specialised fishery items, plastic water bottles to be carried during expedition in mountains, cutlery to be carried in boats / ships / trains, foam packaging products etc.

Applications for use in medical sector should be encouraged.

On - How to judge in the market place – whether a plastic product is really biodegradable or not?

This is an issue on use of Biodegradable Plastics for any mass application. Unless there is any system of traceability and / or accountability, any biodegradable / compostable plastics application cannot be recommended for any mass application like plastic bags or similar commodity items.

On - Technology status and availability at reasonable cost

Technologies have been developed by many reputed and large companies of the world to manufacture compostable plastics / polymers for various applications. Adequate availability is however a constraint. World production of biodegradable (compostable) plastics is estimated at around 0.5 million tons compared to more than 175 million tons for non-biodegradable plastics. Cost is still very high.

On - Role of Government – should it encourage Recycling or biodegradation?

Governments of various developed countries have opted for encouraging recycling over degradation. French Government, which had a proposal to introduce biodegradable plastic carry bags in the entire country by banning normal plastic carry bags, had dropped such plan on the suggestion of the European Union Parliament, which stated that a nation cannot ban a particular product so long it fulfils specific requirements. In other words, plastics recycling is a desired option.

Government of India should encourage and facilitate plastics recycling by providing suitable fringe benefits and tax concessions as per the recommendation of the Supreme Court appointed Burman Committee Report on Solid Waste Management in Class I Cities of India - submitted in March 1999.

Government should also implement the Solid Waste (Management) Rule – 2000, which gives emphasis on segregation of dry and wet waste at source. This would indirectly facilitate recycling of not only plastics waste but also of other dry waste.

Government of India's position should be a facilitator for developing and implementing the use of truly biodegradable plastics (compostable or otherwise) for recommended applications, ensuring that it does not create additional burden on the environment – air, soil or water - visible or not. It should also ensure that appropriate testing facilities are installed in different parts of the country.

Before making a recommendation for a possible application in biodegradable plastics, an LCA study should be conducted to scientifically establish the necessity of such an action.

At SPE's thermoforming conference, a voice questions 'biodegradability'

Narayan argued that the industry should focus more of its energy on recycling and waste-to-energy conversion, saying these are "the best use of plastics." *By Clare Goldsberry*

Published: October 4th, 2010

After materials pricing and the challenge of globalization, it would be hard to find a hotter topic in the plastics industry than sustainability. But the terminology used in that realm is often too "fast and loose" for some experts' tastes, including those of Ramani Narayan, a professor of chemical engineering at Michigan State University. During the recent Society of Plastics Engineers' thermoforming conference in Milwaukee, he railed against the improper use of "biodegradable," and his words found firm footing with many of the attendees.

"The problem is that people are claiming that all you do is put in an additive into the plastics and the material will magically disappear," said Narayan. "Biodegradable is a misused and abused term. What we need is an end-of-life strategy."

Still, he acknowledged that the pubic relations' strength of the word biodegradability carries a lot of weight. "All of this biodegradable stuff sounds good. The public loves it! But, I ask, in what environment will this degrade? Define environment. The word 'biodegradable' means nothing."

According to Narayan, too much flagrant "green washing" is occurring, with companies announcing eco-claims for the products that cannot be backed up with facts. "There are so many misleading biodegradable claims in the marketplace. In high school you'd be failed for creating a chart like this," he said as he held up a chart listing some of what he called the so-called facts of biodegradability.

Narayan argued that the industry should focus more of its energy on recycling and waste-to-energy conversion, saying these are "the best use of plastics." He continued, "Why is replacing petro-carbon with bio-carbon better? Carbon is carbon. There is organic carbon and inorganic carbon. It takes 10 years to turn an inorganic carbon into an organic carbon through biodegradability." —Clare Goldsberry

Conference on

"Sustainable Processing for Solid Waste Management"

Organised Jointly by:

NSWAI and ICPE-ENVIS

Supported by

Dept. of Family Resource Management, S.N.D.T, Juhu, Mumbai

23rd September, 2010

Municipal Solid Waste management is the discipline associated with the control of generation, storage, processing and disposal of Municipal Solid Waste. The increasing pace of urbanization coupled with an increase in per capita waste generation driven by changing urban consumption patterns in view of economic growth and improved living standards is exerting significant additional pressures on already stretched Municipal Solid Waste Management (MSWM) systems across cities in India. This challenge is further aggravated by the lack of adequate capacity, institutional, financial capabilities and lack of skilled resources in collection, transportation, processing and final disposal of these wastes. Today, in most of the cities in India Municipal Solid Waste that is collected is dumped indiscriminately without processing it. This causes harmful effects on air, water and soil at the site as well as few kilometers away from the site. Thus, processing of Municipal Solid Waste before its disposal is the need of the hour.

To emphasize on the processing part of the Municipal Solid Waste, National Solid Waste Management (NSWAI-ENVIS) and Indian Centre for Plastics in the Environment (ICPE-ENVIS) with the support from S.N.D.T Women's University had organized the conference on 'Sustainable Processing for Solid Waste Management' on 23rd September, 2010 at Mini Auditorium, Department of Post Graduate Studies and Research in Home Science. Representatives from Maharashtra Industrial Development Corporation (MIDC), Maharashtra Pollution Control Board (MPCB), Navi Mumbai Municipal Corporation, Officers from Municipal Corporation of Greater Mumbai, Maharashtra Chamber of Commerce, Representatives from various industries like Ambuja Cements Ltd, Reliance Industries Ltd etc participated in the conference. Also, students, research scholars and faculty members from various colleges of Mumbai actively participated in the conference.

The Program commenced at 10:30 am with brief introduction by Ms. Kosha Desai from NSWAI about the theme of the conference and the need for sustainable processing for Effective Solid Waste Management. Dr. Bishnupriya Dasgupta, Reader, Dept. of Family Resource Management, SNDT University welcomed the audience and dignitaries. Dr. Amiya Kumar Sahu, President NSWAI then briefed about the theme of the conference and appraised the previous conferences held in SNDT University to motivate the students in this sector. Subsequently Mr. R. K. Garg, Emeritus President, NSWAI addressed the audience and inaugurated the conference by lighting the lamp

After the inauguration and tea break thereafter, the program resumed with the technical session.

In the technical session, Dr. Amiya Kumar Sahu gave broad overview on various innovative technologies for Municipal Solid Waste Management in India. He emphasized on

various technologies for storage, collection and transportation of Municipal Solid Waste. The technologies include Use of Solar powered compactor, Fully-Automated Trash Collection System, Machine Sweeper Truck and other technologies for Treatment and Disposal like Composting, Waste-to-Energy which include Incineration / Pyrolysis / Gasification / Plasma Arc Gasification/Anaerobic digestion / Bioconversion of biomass to mixed alcohol fuels etc, and other treatment options such as Bio-drying, Bio-stabilization and Sanitary Landfill.

Dr. S. T. Lonkar, Deputy General Manger, SMS Envocare Ltd. presented on 'Waste to Energy by using Plasma Gasification for Hazardous Waste'. He defined the Plasma gasification technology as the Gasification of Matter in oxygen starved environment to dissociate Hazardous waste into its basic molecules and in this process, organic waste gets converted into fuel gas (Syngas) containing all chemical & heat energy. Dr. Lonkar shared the experience of SMS Envocare Ltd, Pune in adopting Plasma Gasification Technology for disposal of hazardous wastes as well as generation of green power at the same time.

The technical session ended with a wonderful film and presentation by Mr. T. K. Bandopadhyay, Convener- ICPE. The film on plastics made us understand how plastics are important to us in our day-to-day life and it is not the plastics that pollute the environment but how we humans handle it is responsible for the pollution of the environment. The presentation titled 'Plastics Recycling and Waste Management' emphasized on different ways of plastic wastes recycling this include conversion of mixed plastic waste to fuel, conversion of selective plastic waste to monomer for re-polymerizing into fresh plastics raw material. Example–Polyethylene Terephthalate (PET plastic bottles). Mr. Bandopadhyay also focused on the need for segregation of wet waste and dry waste and use of plastic waste for road construction. He even mentioned of one such road in Mumbai where plastic waste has been used for the construcion (Prof. V. S. AGHASE ROAD DADAR, MUMBAI)

The conference concluded with concluding remarks by Mr. R. K. Garg, Vote of thanks by Ms. Kosha Desai from NSWAI which was followed by Lunch thereafter.

The conference enlightened our knowledge on the technologies available for sustainable processing and Disposal of Municipal Solid Waste as well as the need and ways for Plastic Wastes Recycling and its Sustainable Management so as to make our Planet Earth - A better place to live in.

IndiaPack 2010: International Packaging Exhibition & Conference

Sep.30 – Oct.3, 2010 – Mumbai

ICPE participated in the Exhibition and showcased the Environmental benefits of plastics. Various issues related to Plastics Waste Management and scientific solutions through appropriate recycling and energy recovery were highlighted by way of Display Panels, Screening of Films and display of Samples of recycled products.

M/s. Doll Plastics, Ahmedabad, manufacturer of plastics recycling plants, informed the public about their new plant to manufacture Plastic Lumber from mixed waste plastics. Doll Plastics are offering commercial plants, which are capable of manufacturing lumber for making school benches etc. The joint effort could increase public awareness in the area of Plastics Waste Management.

EXPLANATORY NOTE

Explanatory Note to the mass awareness campaign (See message on back cover)

Edible oil is an essential commodity which requires appropriate packaging to safeguard its quality over a period of time against being rancid due to the reaction with atmospheric oxygen and other gases. Plastic pouches have proven to be most efficient and cost effective solution to provide safe and unadulterated oil to the consumers. Plastic pouches save energy, water and fuel consumption and emissions of various volatile organic compounds (VOC) during manufacturing and subsequent transportation, compared to the alternate mode of packaging. Polyethylene which is absolutely safe in terms of its use in contact with ready to eat or drink food products is the predominant plastics material used for manufacturing these edible oil pouches.

Normal plastic carry bags are made of the same material which is used in manufacturing Edible Oil Pouches – Polyethylene. The attributes, which have made the use of plastic pouches safe, exists for carry bags also. Still it is alleged that plastic carry bags are not environment friendly. Consider these facts revealed by Life Cycle Impact Studies conducted by credible International Organisations:

- Normal plastic carry bags consume only about 35% of energy compared to that required for manufacturing paper and compostable plastic carry bags.
- The weight of equivalent paper bags is 9 times more than plastic carry bags, which necessitates 10 times more transportation trips for paper bags consuming more fuel and thus causing more environmental pollution.
- Millions of trees would have to be cut every year to manufacture paper carry bags, if normal plastic carry bags are banned.
- Normal plastic carry bags manufacturing process consume only about 5% fresh water compared to that of paper or compostable plastic bags. In real terms, this saving can meet the drinking water requirement of millions of people.
- Plastic bags generate 60% less Green House Gas (GHG) Emission than uncomposted paper bags and 79% less GHG Emissions than composted paper bags. The saving is much more when the comparison is made with compostable plastic or jute bags.
- Plastics bags are recyclable. Paper bags also are recyclable; however it takes 91% more energy for recycling equivalent weight of paper than that of plastics. Compostable or jute bags are not recyclable.
- Paper bags generate 70% more air pollutants and 50% more water pollutants than normal plastic bags do during manufacture.
- Energy Saving during manufacture of raw materials, production and transportation of plastic bags compared to jute bags is 81%.
- Environmental Burden with respect to Air and Water pollution during Production of Raw Material and Bags for Plastic Bags is much less than that created by Jute bags.

Our bad littering habits coupled with inadequate infrastructure for waste management has created the disposal problem of solid waste, including the plastic waste especially in the urban areas. Discontinuation of Plastic bags is no solution and will rather multiply the problem many fold. This will add to the woes of common man as the so called alternatives are nonviable, costly and place greater burden on the environment. The challenge facing us is to improve the solid waste management system and create awareness among general mass against littering.

The solution lies in Segregation of Waste at Source and arrangement for Recycling of all recyclable waste. Plastic Bags are 100% recyclable. Plastic Bags are Environment friendly.

Major Manufacturers of Biodegradable Plastics

USA

Cargill Dow – Bags for compost, Garden refuse, Agricultural Mulch Film, Coated Paper, Flavour and Aroma barriers – replacing Nylon- in multilayer structure.

Products are based on PLA and other lactic acid derivatives.

Trade Name – Nature Works™.

Bioplastics Inc – Compost bags, Mulch Films, Paper Coatings and other applications including one having the properties of Polystyrene and still completely biodegradable.

Products are based on Reactive blends of Starch and Polycaprolactone, cellulose esters, Zein – a Corn Protein, Modified lesuerella and soy bin oils.

Trade Names – ENVAR, Evercorn, SPOL, SPARKA.

Du Pont – Domestic wipes, yard waste bags, top and back sheets of disposable diapers, disposable eating utensils, disposable cutlery, dispensable water bottles - like PET bottles, agricultural films, seed mats, plant bags that covers ripening fruits, coated paper etc.

Products are based on modified polyethylene terephthalate.

Trade Name – Biomax

Chronopol Inc (ACX Technologies Inc) - Food and Fast Food Packaging, Medical and Agricultural applications.

Products are based on PLA.

Novon (Churchill Technologies Inc) – Compost Bags, Trash Bags, Bin Liners and Agricultural Mulch Film.

Products are based on starch and starch blends biodegradable plastics.

Europe

Novamont - Agricultural Mulch Film, Paper lamination, Diaper back sheets, Wrapping film, Garbage bags, Shopping bags, Cutlery, Seedling planter trays, Golf Tees, vending cups etc.

Products are based on blends of thermoplastic starch and synthetic components like poly-G-caprolactone, Cellulose derivatives and polyvinyl alcohol copolymer.

Trade name – Mater-Bi: Not compostable / Master-Bi: Compostable.

BASF – Bags, Coating for paper board, Agricultural Mulch Film.

Trade Name – Ecoflex

Monsanto – (ICI-Zeneca's BIOPOL)- Coated paper bags, coated board for frozen foods, Agricultural Mulch Film, Disposable Cutlery.

Products are based on polyhydroxyalkanoic acid (PHA) produced by fermenting natural resources such as wheat as sugar with microorganisms.

Trade Name – BIOPOL

Biotech – Refuge bags, sacks, shopping bags, agricultural film, foam products for packaging purpose etc.

Products are based on starch.

Trade name – Bioplast, Biopur, Bioflex.

Bayer – Yard waste bags,

Products are based on polyesteramide.

Trade name - BAK

Japan

Showa Highpolymer – Compostable rubbish bags, shopping bags, food packaging, wrapping film, paper lamination, cups, containers, disposable nappies, napkins, Agricultural Mulch Film, Compostable Garbage bags, packaging material for electrical and audio-visual equipment parts etc.

Products are based on thermoplastic aliphatic polyester produced by chemical reaction and polycondensation glycol with dicarboxylic acids and others. Products are polybutylene succinate homopolymers and polybutylene succinate adipate homopolymers.

Trade name – Bionolle

Mitsui Chemicals – Packaging and containers, agricultural, forestry and civil engineering area and composting and waste treatment. Compostable bags, Disposable nappies.

Products based on PLA. The company has also invented a unique technology of manufacturing polylactic acid via a direct condensation polymerisation reaction of lactic acid instead of usual two-step reaction.

Trade name – Lacea

Daicel Chemical Industries – Mulching film, loose fill packaging and also developing foam products.

Products based on polycaprolactone and acetyle cellulose resin.

Trade name – Celgreen

Shimadzu – Fibres for clothing textile, Long Fibres or Short Fibres for soil stabilisation and blending with other compostable grades manufactured by other companies.

Products based on polylactic acid.

Trade name – Lacty for plastics / Lactron – for fibre

Mitsubishi Gas Chemical - Actively associated with Showa Highpolymer and Shimadzu of Japan and Cargill Dow of USA for its Asia market. Pre-paid cards and various compostable plastics. Even Natural Latex Gloves have been manufactured.

Products based on polylactic acid, blend of polyhydroxy butyrate (PHB) and polycaprolactone, polyester carbonate resin.

Trade name - Biogreen

Dainippon Ink & Chemical (with subsidiary in North America and Europe under the name of Reichhold Group)- Compost bags, cushioning material, packaging applications, agricultural and fishing materials and sanitary products.

Products based on lactic acid copolymerised with aliphatic polyester and a catalyst.

Aicello Chemical - Pharmaceutical capsules, Fishing and Agricultural products

Products based on Chitosan, cellulose and starch.

Trade name – Doron CC

The pouch that packs your cooking oil and the bag you carry for shopping are made from the same material.

That's why plastic bags are not harmful.

For more information visit **www.icpeenvis.nic.in**

Issued in public interest by Indian Centre for Plastics in the Environment.

ICPE
REUSE • RECYCLE • RECOVER

Do not litter.
Plastics are recyclable.